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# Analyses of Factors That Affect Mill Consumption of Cotton in the United States

By Frank Lowenstein and Martin S. Simon

*Research discussed in this article represents one phase of a comprehensive project designed to study the demand for the principal textile fibers in this country—cotton, wool, and synthetic fibers. Results from the larger study are to be reported in a technical bulletin which will include a more detailed version of this paper, possibly slightly revised if warranted by research still in progress. From the standpoint of quantities consumed, cotton is by far the most important fiber of the group. Annual variations in total fiber consumption—including flax and silk—have conformed rather closely to those for cotton, despite the steady advance in use of synthetics. Determination of factors primarily responsible for variations in cotton consumption and their relative significance is a noteworthy step toward understanding fluctuations in the use of all fibers in the aggregate.*[1]

CONSUMPTION OF COTTON in the United States far exceeds that of all other textile fibers taken together. In 1952, for example, 28 pounds of cotton per capita were consumed compared with a total of approximately 12 pounds of wool, synthetic fibers, flax, and silk. The relative advantage of cotton was even greater in earlier years. Figure 1 shows the varying trends in consumption of the principal textile fibers in this country.

An analysis of factors that affect domestic mill consumption of cotton—henceforth designated Analysis I—was published in the April 1952 issue of this journal.[2] As a consequence of research since 1952 and some additional data, the demand equation for cotton in the domestic market has been modified and extended. The modification involves substitution of (1) deflated personal disposable income and the year-to-year change in such income for the index of industrial production, and (2) consumption of all synthetic fibers for that of rayon and acetate alone. The extension consists of the incorporation of data that measure the degree of imbalance existing at any given time at the mill level between the supply of, and the level of demand for, cotton broad woven goods. Because of its novelty, special attention is given to the nature and use of this new measure. The revised analysis is a distinct improvement over Analysis I.

In considering these changes and their significance, this paper uses the following procedure.

[1] Research on which the report is based was made under authority of the Agricultural Marketing Act of 1946 (RMA, Title II). The authors are indebted to the American Cotton Manufacturers Institute, Inc. for basic data relating to stocks and unfilled orders of cotton cloth, especially to Claudius T. Murchison and William T. Shymanski.

[2] Lowenstein, Frank. Factors affecting the domestic mill consumption of cotton. Agricultural Economics Research 4: 44–51. April 1952.



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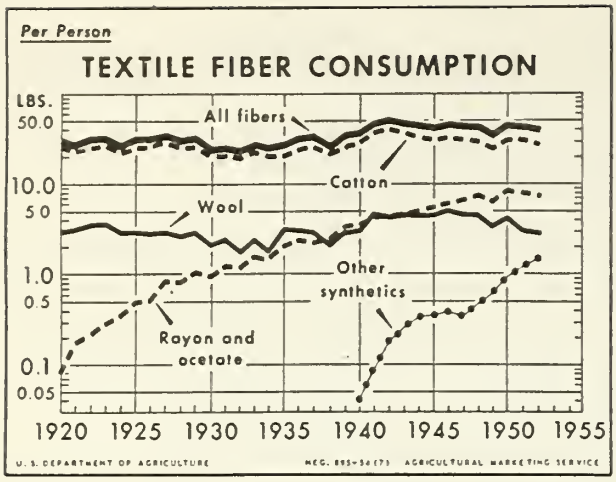


FIGURE 1.—The vertical scale of this figure is logarithmic, thus enabling comparison of percentage changes over time. Cotton is far in front of other fibers but has steadily lost ground during the last 3 decades. In 1952 cotton consumption per capita represented 69 percent of total fiber consumption—including flax and silk—compared with 88 percent in 1920, 85 percent in 1930, and 81 percent in 1940.

First, a brief recapitulation of statistical aspects of Analysis I is given as background material. Second, the modifications of Analysis I and the results therefrom are discussed under Analysis II. The measure of imbalance in the mill supply-demand relation for cotton broad woven goods is then considered and results from its use are given as Analysis III. Because of a lack of data for the imbalance measure, Analysis III covers fewer years than Analysis II. For comparison, Analysis IV was run for the same years as Analysis III and with the same variables as Analysis II. The principal statistical coefficients obtained from each of the four analyses are shown in table 1.

## Analysis I—Industrial Production

Analysis I is based on the years 1921–40 and 1947–50 and uses the following variables:

$X_1$=mill consumption of cotton per capita

$X_2$=Federal Reserve Board index of industrial production (1935–39=100), on a per capita basis

$X_3$=rayon consumption per capita

$X_4$=average annual price of Middling, 7/8-inch cotton at the 10 spot markets deflated by the Bureau of Labor Statistics index of wholesale prices (1926=100).

A lead of 6 months was used for $X_4$ on the assumption that the quantity of cotton consumed by mills was influenced more by the purchase price of cotton than by the concurrent market price. $X_4$ thus comprises data for years beginning in July, whereas $X_1$, $X_2$, and $X_3$ are based on calendar years. As the relation between these variables is believed to be proportional rather than linear, the analysis was run with the variables expressed in logarithms.

Table 1 shows the principal statistical results obtained from Analysis I. The three independent variables explained 79 percent of the variation in mill consumption of cotton per capita.

The equation expressing the relation between the variables follows:

$$\text{Log } X_1 = 6.94 + 0.84 \log X_2 - 0.12 \log X_3 - 0.30 \log X_4$$

As the analysis was run in logarithms, the net regression coefficients show the approximate percentage change in the per capita consumption of cotton for a 1-percent change in each of the independent variables with the other independent variables held constant.

## Analysis II—Substitution of Income and Consumption of All Synthetic Fibers

Analysis II differs from Analysis I in two respects: (1) Personal disposable income and the change in disposable income from the previous year, both adjusted for price changes, are used in place of the index of industrial production to measure changes in general demand conditions that affect cotton consumption. (2) Consumption of all synthetic fibers—rayon, acetate, nylon, orlon, and others—instead of consumption of rayon and acetate alone is used to represent the effect of substitute fibers.

In demand analyses, personal disposable income is commonly used as the demand shifter for consumer goods. The index of industrial production is frequently employed when the commodity considered is essentially an industrial raw material.[3] Cotton cannot be said to satisfy either criterion exclusively. The largest outlets for cotton are in items directly associated with consumer demand and easily identifiable as cotton products. In peacetime years since 1939, 60 percent or more of the cotton that was traced to various end uses

[3] FOOTE, RICHARD J., and FOX, KARL A. ANALYTICAL TOOLS FOR MEASURING DEMAND. U. S. Dept. Agr. Handbook No. 64. January 1954. Page 9.

TABLE 1.—*Principal statistical coefficients from 4 analyses of factors that affect mill consumption of cotton, United States* [1]

| Correlation coefficient | Analysis | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | I | | II | | III | | IV | |
| | Value | Standard error | Value | Standard error | Value | Standard error | Value | Standard error |
| Multiple determination, $R^2$ | 0. 79 | | 0. 75 | | 0. 95 | | 0. 84 | |
| Standard error of estimate | . 03 | | . 03 | | . 02 | | . 03 | |
| Highest order: | | | | | | | | |
| Partial regression: | | | | | | | | |
| $b_2$ | . 84 | 0. 13 | . 89 | 0. 16 | . 92 | 0. 13 | 1. 05 | 0. 23 |
| $b_3$ | —. 12 | . 03 | . 82 | . 22 | . 93 | . 16 | 1. 15 | . 27 |
| $b_4$ | —. 30 | . 09 | —. 09 | . 03 | —. 09 | . 03 | [2] —. 12 | . 04 |
| $b_5$ | | | —. 24 | . 08 | —. 23 | . 06 | [2] —. 27 | . 10 |
| $b_6$ | | | | | —. 08 | . 02 | | |
| Partial determination: [3] | | | | | | | | |
| $r^2_2$ | . 69 | | . 61 | | . 81 | | . 64 | |
| $r^2_3$ | . 46 | | . 41 | | . 75 | | . 60 | |
| $r^2_4$ | . 34 | | . 37 | | . 54 | | [2] . 38 | |
| $r^2_5$ | | | . 32 | | . 60 | | [2] . 37 | |
| $r^2_6$ | | | | | . 71 | | | |

[1] These values relate to the regression equations when all variables, except $X_6$, are expressed in logarithms. See pp. 102, 105, and 110 for variables in these analyses.

[2] This coefficient differs significantly from zero at the 5-percent probability level but not at the 1-percent level.

[3] Square of the partial correlation coefficient.

was used in items of apparel and in household products (table 2). The other main use of cotton is for industrial purposes. However, the use of cotton for industrial purposes has been declining both relatively and absolutely in recent years.

Industrial products that use cotton include such items as bags, shoes, tire cord, automobile upholstery, insulation, cordage and twine, and tarpaulins. Chains of technical coefficients connect the demand for the raw cotton in these uses with

TABLE 2.—*Cotton: Quantities consumed by category of use, 1939–53*

| Year | Quantity [1] | | | | Percentage distribution | | |
|---|---|---|---|---|---|---|---|
| | Apparel | Household | Industrial | Total | Apparel | Household | Industrial |
| | *1,000 bales* | *1,000 bales* | *1,000 bales* | *1,000 bales* | *Percent* | *Percent* | *Percent* |
| 1939 | 2, 276 | 1, 638 | 2, 440 | 6, 354 | 36 | 26 | 38 |
| 1940 | 2, 143 | 1, 827 | 2, 639 | 6, 609 | 32 | 28 | 40 |
| 1941 | 2, 526 | 1, 958 | 3, 361 | 7, 845 | 32 | 25 | 43 |
| 1942 | 2, 346 | 1, 748 | 3, 173 | 7, 267 | 32 | 24 | 44 |
| 1943 | 2, 807 | 1, 575 | 3, 347 | 7, 729 | 36 | 21 | 43 |
| 1944 | 2, 630 | 1, 401 | 3, 167 | 7, 198 | 37 | 19 | 44 |
| 1945 | 2, 430 | 1, 317 | 3, 036 | 6, 783 | 36 | 19 | 45 |
| 1946 | 2, 414 | 1, 748 | 3, 051 | 7, 213 | 34 | 24 | 42 |
| 1947 | 2, 740 | 2, 288 | 2, 935 | 7, 963 | 34 | 29 | 37 |
| 1948 | 2, 741 | 2, 255 | 2, 739 | 7, 735 | 36 | 29 | 35 |
| 1949 | 2, 749 | 2, 116 | 2, 446 | 7, 311 | 38 | 29 | 33 |
| 1950 | 3, 122 | 2, 655 | 2, 687 | 8, 464 | 37 | 31 | 32 |
| 1951 | 3, 008 | 2, 600 | 2, 611 | 8, 219 | 36 | 32 | 32 |
| 1952 | 3, 220 | 2, 650 | 2, 190 | 8, 060 | 40 | 33 | 27 |
| 1953 [2] | 3, 387 | 2, 734 | 1, 938 | 8, 059 | 42 | 34 | 24 |

[1] These estimates do not account fully for the total consumption of cotton as reported by the Bureau of the Census. Generally less than 30 percent of the reported total was not covered, part of which presumably was exported as finished or semifinished products.

[2] Preliminary.

National Cotton Council of America.

demand for finished products. Some finished products that use "industrial cotton"—automobiles, shoes, and luggage for instance—are basically consumer goods,[4] demand for which would be affected by changes in consumer income. On the other hand, demand for industrial products such as insulation, machinery belts, and industrial thread is related only remotely to demand by ultimate consumers for the products manufactured.

In Analysis I the index of industrial production soloed, so to speak, as the indicator of consumer and industrial demand for cotton. Major movements in industrial production are closely similar to those in consumer income. This would imply that, even if consumer income is the proper representative of consumer demand for cotton, the high correlation between it and industrial production would tend to minimize any error resulting from use of industrial production for this purpose.

Because of the declining importance of industrial uses and the increasing importance of apparel and household uses, it would be particularly desirable to use demand shifters that relate directly to each segment of demand for cotton. As total industrial production and consumer income are highly intercorrelated, it was not possible to use both of them as independent variables in a regression analysis. It was hypothesized that the components of the index of industrial production that represent the important industrial consumers of cotton, such as nondurable goods, might be closely related to cotton consumption and still not be too highly intercorrelated with consumer income.

The index of industrial production was broken into some of its components parts. These components were then correlated with cotton consumption per capita. But the evidence failed to fit the hypothesis. Segments of industrial production that apparently were most highly correlated with cotton consumption were iron and steel and minerals production.[5]

There is no logical causal relationship between either of these industries and cotton consumption. Neither industry makes products that contain cotton to an important extent. But iron and steel and minerals apparently do react to changes in general business conditions much as the cotton textile industry does. This being true, a better analysis of causal factors affecting consumption of cotton would be obtained by using the general factor as a demand shifter and eliminating the intervening industries. Based on the foregoing, the index of industrial production is not so well suited as consumer income for the role of a primary demand shifter.

Apparently both current and last year's income are significant in this respect. In Analysis II, $X_2$ denoted deflated disposable income per capita. This variable measures the influence on cotton consumption of the level of income in the current year. Consumer demand for cotton products is affected also by the direction of the change in income from the year earlier. As most cotton products are semidurable, consumers within certain limits can "live off" inventories and can postpone purchases or defer replacement of some items when income is declining. Similarly, they may replace worn or out-of-style items sooner and "stock up" on others when income rises.[6] In Analysis II change in income is denoted at $X_3$.

An indication of the importance of the effect of change in income on cotton consumption can be obtained by recourse to Analysis II. With the other factors in the analysis held constant at their average level for 1948–52, cotton consumption would have been 28.8 pounds per person if current real income at its 1948–52 average level of $1,269 per person were unchanged from the year earlier; 31.4 pounds per person if the $1,269 per capita reflected a 10-percent rise in real income from the preceding year; and 26.6 pounds if the year's real income of $1,269 per person were 10 percent under that of the preceding year.

[4] The National Cotton Council of America, in connection with its estimates of the quantity of cotton consumed by end use (table 2), stated: ". . . Articles whose cotton content is quite secondary to some other material—the leather in shoes for example—are classified as 'industrial.' In keeping with general practices, the term 'industrial' has been employed to cover all uses other than 'apparel' and 'household.' " NATIONAL COTTON COUNCIL OF AMERICA, COTTON COUNTS ITS CUSTOMERS, revised 1952 and preliminary 1953. Memphis, Tenn. June 1954. Page 4.

[5] Results of these analyses and additional analyses now in progress will be discussed in the forthcoming technical bulletin.

[6] For a discussion of income and changes in income as they affect demand for durable consumer goods, see ATKINSON, L. JAY. THE DEMAND FOR CONSUMERS' DURABLE GOODS. U. S. Dept. Commerce Survey of Current Business. Vol. 30, No. 6. June 1950.

$X_4$ in Analysis II represents the per capita consumption of all synthetic fibers, whereas in Analysis I the per capita consumption of rayon and acetate alone was used. Use of the newer synthetics as a group—nylon, orlon, dacron, and others—has been increasing at a rate similar to that for rayon in its formative years (fig. 1). The sharp growth trend in consumption has been the primary factor in demand for the newer synthetic (noncellulosic) fibers in the postwar years as it was for rayon in the interwar years. Until the end of the 1930's the growth factor tended to mask the effect of market forces, such as income, on rayon consumption. As a percentage of total synthetic fiber consumption, consumption of rayon has steadily declined, dropping to about 80 percent in 1953 from 95 percent in 1947. The newer synthetics are taking markets away from rayon and, perhaps to a small extent, from cotton. In many types of tires, for example, rayon tire cord, having almost completely replaced cotton, is now being succeeded by nylon tire cord.[7] Although use of the newer synthetics still is relatively small, comprising less than 5 percent of total fiber consumption in 1953, the likelihood of their continued rapid growth and imposition on the markets for other fibers warrants their inclusion in the analysis at this time.

To review, the variables used in Analysis II are as follows:

$X_1$=mill consumption of cotton per capita [8]
$X_2$=deflated disposable income per capita
$X_3$=change from the preceding year in deflated disposable income per capita
$X_4$=synthetic fiber consumption per capita
$X_5$=deflated average annual price of Middling, 7/8-inch cotton at the 10 spot markets, year beginning the preceding July.

Analysis II was based on data converted to logarithms for the years 1920–40 and 1947–52. Series used in Analysis II are given in table 3. Results are shown in table 1.

[7] Data from the Bureau of the Census indicate that more nylon tire cord and tire cord fabrics are now being produced than such cord and fabrics (excluding chafer fabrics) made from cotton.

[8] This variable differs slightly from that used in Analysis I in that it incorporates recent revisions made in the population and cotton consumption series.

The four factors explained 75 percent of the fluctuations in mill consumption of cotton. On the average, a 1-percent change in personal real dis-

TABLE 3.—*Analysis II: Factors that affect mill consumption of cotton, United States, 1920–52*

| Year | Per capita | | | Deflated price per pound of cotton, year beginning preceding July [4] |
|---|---|---|---|---|
| | Mill consumption of cotton [1] | Disposable income, deflated [2] | Consumption of synthetic fibers [3] | |
| | *Pounds* | *Dollars* | *Pounds* | *Cents* |
| 1920 | 26. 14 | 748 | 0. 08 | 24. 75 |
| 1921 | 23. 62 | 651 | . 18 | 15. 32 |
| 1922 | 26. 09 | 740 | . 22 | 18. 31 |
| 1923 | 27. 51 | 829 | . 29 | 25. 24 |
| 1924 | 22. 79 | 817 | . 36 | 30. 44 |
| 1925 | 26. 17 | 829 | . 50 | 24. 52 |
| 1926 | 27. 00 | 843 | . 51 | 19. 75 |
| 1927 | 29. 74 | 849 | . 83 | 14. 90 |
| 1928 | 26. 08 | 872 | . 82 | 20. 18 |
| 1929 | 27. 74 | 911 | 1. 08 | 19. 67 |
| 1930 | 20. 97 | 826 | . 95 | 17. 61 |
| 1931 | 21. 10 | 771 | 1. 26 | 12. 53 |
| 1932 | 19. 46 | 647 | 1. 23 | 9. 02 |
| 1933 | 23. 96 | 642 | 1. 71 | 10. 70 |
| 1934 | 20. 76 | 705 | 1. 54 | [5] 19. 86 |
| 1935 | 21. 36 | 765 | 2. 01 | [5] 21. 01 |
| 1936 | 26. 74 | 858 | 2. 48 | [5] 16. 84 |
| 1937 | 27. 92 | 886 | 2. 33 | 15. 11 |
| 1938 | 22. 18 | 824 | 2. 50 | 10. 84 |
| 1939 | 27. 34 | 891 | 3. 46 | 11. 20 |
| 1940 | 29. 55 | 943 | 3. 63 | 12. 57 |
| 1941 | 38. 37 | 1, 081 | 4. 46 | 12. 82 |
| 1942 | 41. 21 | 1, 225 | 4. 72 | 18. 67 |
| 1943 | 38. 03 | 1, 292 | 5. 01 | 18. 85 |
| 1944 | 34. 14 | 1, 392 | 5. 37 | 18. 87 |
| 1945 | 31. 85 | 1, 385 | 5. 79 | 19. 57 |
| 1946 | 33. 54 | 1, 329 | 6. 50 | 21. 78 |
| 1947 | 31. 93 | 1, 215 | 7. 10 | 23. 83 |
| 1948 | 30. 02 | 1, 232 | 8. 22 | 21. 07 |
| 1949 | 25. 37 | 1, 216 | 7. 17 | 19. 02 |
| 1950 | 30. 45 | 1, 302 | 9. 70 | [6] 19. 72 |
| 1951 | 30. 99 | 1, 295 | 9. 46 | 23. 89 |
| 1952 | 28. 16 | 1, 300 | 9. 25 | 22. 11 |

[1] Mill consumption expressed as pounds of lint cotton, divided by the population of continental United States on July 1, including Armed Forces overseas, Bureau of the Census, adjusted for underenumeration of all age groups.

[2] Disposable personal income, estimated by the Agricultural Marketing Service for 1920–28 and by the Department of Commerce since 1929, divided by the population as described in footnote 1, and deflated by Bureau of Labor Statistics consumers' price index (1947–49=100).

[3] United States producers' domestic shipments and imports for consumption of rayon and acetate since 1920 plus nylon, orlon, glass fiber, etc., since 1940, *Textile Organon*, publication of the Textile Economics Bureau, Incorporated, divided by the population as described in footnote 1.

[4] Average price of cotton, American Middling, 7/8-inch at 10 spot markets, Agricultural Marketing Service, deflated by Bureau of Labor Statistics wholesale price index (1926=100).

[5] For the period August 1933 to December 1935 a processing tax of 4 cents a pound gross weight is added to the cotton price.

[6] Eleven-month average.

posable income was associated with a change of 0.9 percent in consumption of cotton in the same direction. Similarly, if the other factors remain unchanged, a 1-percent change in the ratio of the current to the preceding year's deflated personal disposable income was associated with a change of 0.8 percent in the same direction. These income relationships indicate that current income has about twice as much effect on cotton consumption as does last year's income.[9]

The other independent variables had a significant but smaller effect. On the average, a 1-percent change in consumption of synthetic fibers was associated with a change in cotton consumption in the opposite direction of 0.1 percent and a 1-percent change in the price of cotton was associated with an opposite change in consumption of 0.2 percent. The regression equation for Analysis II was as follows:

$$\text{Log } X_1 = -0.90 + 0.89 \log X_2 + 0.82 \log X_3 - 0.09 \log X_4 - 0.24 \log X_5$$

Comparison of the results from Analysis II with those from Analysis I reveals only minor differences in the value of the coefficients (table 1). On logical grounds, Analysis II is preferred.

## Analysis III—Stocks, Unfilled Orders, and Cotton Consumption

In the formulations of the demand equations for cotton discussed heretofore, a relatively large proportion of the variation in consumption was left unexplained—25 percent in the case of Analysis II. Some part of the unexplained variation probably reflects the degree to which consumer income is deficient in representing the level of mill demand for cotton. Sources of demand for cotton textiles not explicitly taken into account in Analysis II include industrial, foreign, military or defense, and inventory demand. Industrial demand, as indicated, has trended downward in recent years. For the most part it is satisfactorily represented, though indirectly, by consumer income.

Neither foreign nor military or defense demand for cotton products was apparently large enough in most years to warrant inclusion in the analysis. Reliable published data on quantity of cotton annually consumed in the United States for military or defense purposes are not at present available. Although military purchases of cotton items in connection with wars and defense emergencies undoubtedly have a notable effect on mill consumption of cotton,[10] in most peacetime years before World War II this source of demand was probably stable and of minor significance. Hence, failure to account for military demand in an analysis covering essentially a peacetime period before World War II would not be likely to affect seriously the results obtained. It may have had more importance since 1945; it is hoped that data on military demand for the postwar years can eventually be obtained.

Export demand for manufactured textiles also appears to be relatively stable. Except for the immediate post-World War II period when shortages of productive factors abroad kept foreign demand for United States cotton products unusually high, exports of cotton goods, in terms of equivalent pounds of raw cotton, seldom exceeded 8 percent of domestic mill consumption of cotton during 1920–52. An analysis differing only in the use of per capita mill consumption of cotton adjusted for the raw cotton equivalent of cotton manufactures in foreign trade as the dependent variable, gave results similar but slightly inferior to those obtained from Analysis II.

Inventory demand is another matter. In any given period mill consumption of cotton may be out of balance with consumer purchases of cotton products because of changes in inventories at various levels of fabrication and distribution. For example, when inventories of cotton products are being built up at any level of marketing, the increments represent an increase in demand for cotton fabrics, and hence for cotton, over and above current consumption.

Of importance among factors that affect inventories are changes in sales or expectations thereof. Merchants may try to keep inventories in a fixed—

[9] Using the relevant part of the demand equation, this may be demonstrated by simple algebraic manipulation as follows:

$\text{Log } X_{1t} = 0.89 \log X_{2t} + 0.82 \log X_{3t}$.

But $\log X_{3t} = \log X_{2t} - \log X_{2t-1}$

so $\log X_{1t} = 0.89 \log X_{2t} + 0.82 (\log X_{2t} - \log X_{2t-1})$

$= 1.71 \log X_{2t} - 0.82 \log X_{2t-1}$.

[10] The relatively large difference between actual and "calculated" consumption of cotton in 1951 (fig. 3) is probably due in part to the increase in the military demand for cotton products arising out of hostilities in Korea.

or relatively fixed—ratio to their rate of sales. If consumer purchases of cotton goods decline, merchants would try, other factors being the same, to adjust inventories to a level commensurate with the changed conditions of demand. Current demand would be satisfied temporarily from stocks of goods produced in the past. Orders for cotton products thus would tend to decline by an amount greater than that of the decrease in retail sales. As the decline in demand spreads to preceding stages of distribution and manufacture, it would grow in intensity to the extent that inventories on these levels also are reduced proportionately. Ultimately, the magnified reduction in consumer demand is reflected back to the mill level.[11] A result of the adjustments in inventories along the line is a rate of cotton consumption less than that indicated by the decrease in consumer demand. Although inventory changes may bear some relationship to changes in consumer income, the latter measure could not be expected to account fully for the effect of the former on mill consumption of cotton.

Other factors that affect demand for goods for inventory, given the marketing and technological structure of the industry, include fears of shortages, expectations concerning price changes, and other facets of the economic outlook. Prices themselves are not immune to inventory changes. For example, the decision to acquire additional stocks, perhaps in line with a rise in consumer purchases, would add to the upward pressure on prices for textiles. The price rise, in turn, induces, for speculative and precautionary reasons, further increases in stocks and an inventory-price-inflation spiral may develop. Thus actions taken with respect to stocks may affect and be affected by prices.

In addition to changes in inventory, the size of the total inventory in the cotton textile system is to be noted. Obviously, the larger this inventory, the deeper will be the effect of, and the longer the adjustment to, a decline in consumer demand. Conversely, if demand were to increase suddenly and sharply, with inventories overly low, an industry-wide speculative movement could be generated because of the prevailing tight supply condition.[12] Stocks of cotton goods thus affect demand schedules for cloth and hence mill demand for cotton.

A change in demand for cotton goods is translated at the mill level into a change in volume of new business both for immediate and future delivery. The reaction of output to a change in demand, however, is usually not instantaneous. It takes time for production to adjust to a new level of sales. Influential among reasons for the relatively slow response of production are the momentum of the manufacturing process, uncertainty concerning the lasting nature of the change, the time it takes to obtain additional materials or to cancel orders, and cost and time considerations relating to removing shifts and shutting down looms or to adding shifts and starting up idle equipment. Initially, mill stocks of cotton textiles[13] would tend to bear the brunt of a change in demand, probably varying inversely to it. Theoretically, adjustment in output, when it comes, would account for the involuntary change in stocks plus any tendency for mill inventories of textiles to be brought into line with the new level of demand. Hence cotton consumption would be expected to reflect both the lag in response of output to a change in demand and the resulting adjustment in level of stocks.

Adjustment in production is often carried too far; that is, output is found to be forthcoming at a rate too high or too low when compared with the level of demand. Hence it may more than compensate for the earlier change in stocks. If output were maintained at a level above that of demand, textile stocks would tend to accumulate. But if output were cut back and maintained below the level of demand, stocks would tend to decline. If, concurrently, demand were to shift in the opposite direction the imbalance could be magnified. Ultimately production would have to be adjusted and, if carried too far again, could affect

[11] The tendency for moderate variations in consumer demand to be converted into more drastic changes in demand for the various goods in process is known in economic theory as the acceleration principle. See HABERLER, GOTTFRIED. PROSPERITY AND DEPRESSION. League of Nations, Geneva. 1941.

[12] See DAVIS, HIRAM S. INVENTORY TRENDS IN TEXTILE PRODUCTION AND DISTRIBUTION. The Textile Foundation. Washington. 1941.

[13] The term "cotton textiles" as used here refers to semifinished items produced at the mill, including primarily cotton fabrics, knit goods, and sales yarn.

stocks similarly but in an opposite direction.[14]

Prices of cotton textiles, actual or expected, have been omitted from the preceding discussion but actually they are interwoven into the dynamics of the industry. The apparent tendency of price to respond almost immediately to changes in the demand for cotton textiles is *prima facie* evidence of the lagged output response. If the change in demand is sudden, following a period of stock accumulation or liquidation, the effect on prices can be extreme until the necessary adjustment is made in stocks and output. If the change in price initiates a further change in inventory demand and possibly a price-inventory spiral up the line, the shift in demand would be greater and the supply adjustment required by the industry magnified. When prices are thought to be fully discounted and production curtailment is proceeding apace, the desire to cover forward at low prices or the incentive to acquire stocks in anticipation of higher prices may initiate a buying wave. At this point risks connected with stock acquirement may be low compared with those associated with the continued deferment of needs. The low textile prices also may lead to an increase in retail sales with all its back ramifications on the demand for textiles. On the other side, expectations of lower prices may cause a general falling off in demand.

Largely as a consequence of these varied forces and their interrelationships, mill product stocks tend to change in a cyclical fashion, frequently being out of line with demand. The tendency for output to be kept at relatively high levels in the short run despite unfavorable economic conditions apparently is characteristic of the cotton textile industry.[15] Clearly the tendency on the part of the industry not to respond readily or properly to changes in demand can affect the timing and extent of mill consumption of cotton considerably and, if possible, should be accounted for in the mathematical formulation of mill demand for cotton.

Recently the American Cotton Manufacturers Institute, Inc.—henceforth designated as the Institute—made available to the United States Department of Agriculture for research purposes data on production, stocks, and unfilled orders of cotton broad woven goods in physical units at the mill level. The data are given in terms of yards of cotton cloth in a time series beginning with January 1928 and continuing by months to the present, with the exception of the period January to July 1933, when no information was collected. Stock and unfilled orders data represent the mills' position as of the end of a reporting period, generally at or near the end of a calendar month. Data on production cover the intervening period; hence they coincide approximately with a calendar month. Similar data for 1926 and 1927 were obtained from reports of the Association of Cotton Textile Merchants of New York—henceforth designated as the Association.[16]

Because mills participate in the Institute's statistical program on a voluntary basis, the percentage of the industry covered by the reports tends to vary. Apparently the sample is much more comprehensive now than when collection of these data was first begun in 1926.[17] Data before October 1927 at least are known not to be comparable with later figures. As of June 1953 the sample comprised a wide range of fabrics and, according to the Institute, it represented about 72 percent of the cotton broad woven goods industry.[18]

Census reports for 1947 indicate that about 75 percent of yarn spun from cotton was woven into cloth, 9 percent was used by the knit-goods industry, 9 percent was used in tire cords, and the rest was used in making threads, twine, cordage, carpets, and other goods. Thus, the Institute data could be considered currently to represent roughly

[14] The apparent tendency in the industry for buying movements to come in irregular and concentrated spurts also may be partly responsible for the sharp variations in mill stocks of cotton textiles, by causing sudden and severe shifts in demand.

[15] See Treanor, Glen R., and Magnusson, Olga L. THE COTTON TEXTILE INDUSTRY. U. S. Bureau of Internal Revenue. December 1948. Page 16.

[16] To the authors' knowledge, data obtained from the Institute for the period beginning August 1933 as described are not available to the general public. Data for August 1927 to December 1932 are published in the BAE report, Waugh, Frederick V., Farrington, Carl C., and Cooper, Maurice R. RECENT DEVELOPMENTS IN THE DOMESTIC COTTON TEXTILE INDUSTRY. U. S. Bur. Agr. Econ. September 1933. Table 8.

[17] For a brief history of the early collection of these data, see The Association of Cotton Textile Merchants of New York. 25 YEARS. 1944. Pages 21–22.

[18] Comparison of the Institute series on production of cotton broad woven goods with that reported quarterly by the Bureau of the Census shows that the Institute's data comprised from 49 to 70 percent of the Census series from first quarter 1943 to first quarter 1953, with an average of about 63 percent.

50 percent of the total cotton textile industry. Because of the varying degree of industry representation, and hence the lack of strict comparability over time, it was found advisable to use the data in a ratio form to adjust roughly for changes in the reporting sample.

The ratio of mill stocks of cotton cloth to unfilled orders was computed as of the end of each month for the full period covered by the data. The average end-of-month ratios for 1926–32 and 1934–52 are shown in figure 2. The ratio reflects the degree of imbalance between stocks, output, and demand at the mill level. When the ratio is relatively high, unless an increase in demand is forthcoming, a downward adjustment in output to reduce stocks is indicated. Conversely, a relatively low ratio suggests the likelihood of a higher output rate in the near future. The ratio indicates also the cyclical character of changes in inventories of mill products.

Obviously some inventory is necessary if a business is to function properly and efficiently. The amount of inventory not considered excessive may vary directly with the volume of business, so that a relatively constant ratio between the two is sought. Whether mill stocks of cotton cloth are too high or too low at a given time probably depends more on the amount of business expected in the near future—reasonably approximated by the level of unfilled orders—than on past volume.

Some "normal" ratio of stocks to unfilled orders thus may be postulated about which the actual ratio would fluctuate and toward which it would tend. Departure from normal—indicative of imbalance in the industry—would be expected to lead to changes in mill consumption of cotton. For want of information, it was decided to use the average of the ratios as normal.

The average level of the ratios shifted from almost one in the prewar period 1926–40 to slightly more than one-third in the postwar period 1947–52 (fig. 2). The shift appears to be a structural one and hence more or less permanent. To account for it in measuring the degree of imbalance, both prewar and postwar average ratios were used and deviations from these normals were computed. Although the normal ratios used are still open to debate and are not to be regarded as fixed, they are apparently the best estimates possible under the circumstances.

The residuals from Analysis II in logarithms

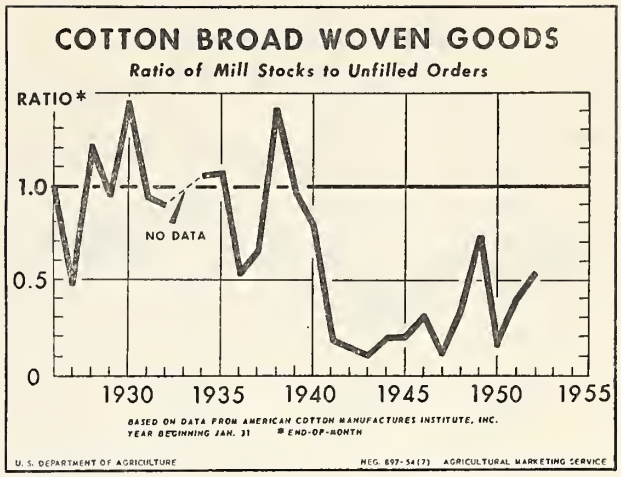


FIGURE 2.

were found to be fairly closely correlated with actual deviations from normal of the stock-unfilled order ratio for cotton cloth. The best result—a coefficient of correlation of −0.85—was obtained when the new variable led the residuals series by 5 months. This lead is consistent with the 3 to 6 months' lead that would have been expected from *a priori* considerations.[19]

To throw more light on the importance of the effect of imbalance in mill inventories of cotton cloth on mill consumption of cotton, the deviations of the stock-unfilled order ratio from normal were added as a fifth independent variable in Analysis III. As the new variable is believed to affect mill consumption of cotton in an additive fashion, actual deviations from normal were used. The other variables are the same as in Analysis II and they were kept in logarithms when the analysis was run. Analysis III is based on 1927–32, 1935–40, and 1948–52, the only full years for which data on stocks and unfilled orders are available when a lead of 5 months is employed. The results of Analysis III, as shown in table 1, are surprisingly good, considering that, because of fewer observations and an additional variable, there are 9 less degrees of freedom than for Analysis II. All of the coefficients are statistically significant.

[19] The coefficient of correlation obtained using a 5-month lead was only slightly higher than those obtained using a lead of 3, 4, or 6 months. In actuality there may be greater flexibility toward the expansion of output than toward curtailment but, even if the data permitted this to be taken into account, it is not likely results would be significantly improved from a statistical standpoint.

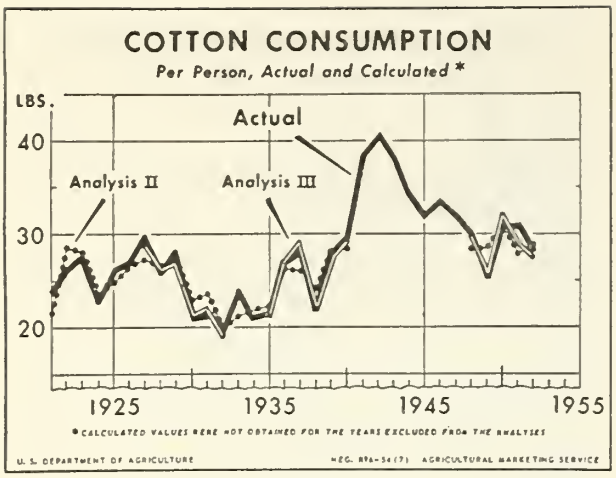


FIGURE 3.

The five factors—real disposable income, the change in this income, consumption of synthetic fibers, deflated purchase price of cotton, and actual deviations from normal of the stock-unfilled order ratio for cotton cloth at the mill—explained 95 percent of the variation in mill consumption of cotton per capita. On the average, an actual deviation of 0.1 points from normal in the stock-unfilled order ratio was associated with a change in cotton consumption of 0.08 percent in the opposite direction. The other regression coefficients, within sampling limits, are nearly the same as those obtained from Analysis II. Changes in actual deviations from normal of the stock-unfilled order ratio, on the average, account for a larger percentage of the variation in mill consumption of cotton than does the price of cotton or the consumption of synthetic fibers, after allowing for the effects of the other independent variables. Changes in disposable personal income and changes in the ratio of the current to the preceding year's income, in that order, are still more important in this respect. (See the coefficients of partial determination shown in table 1.) The regression equation for Analysis III was as follows:

$$\text{Log } X_1 = -1.00 + 0.92 \log X_2 + 0.93 \log X_3 - 0.09 \log X_4 - 0.23 \log X_5 - 0.08 X_6$$

Figure 3 shows the values for cotton consumption calculated from this regression equation for 1927–32, 1935–40, and 1948–52. The closer fit obtained with this formulation of the demand equation for cotton is immediately evident. Inventory imbalance at the mill level apparently accounted in large part for the sharp decline in mill consumption of cotton per capita in 1938 and 1949. The frequent disparities between output and sales, as reflected in recurrent accumulations of stocks of cotton cloth at the mill, evidently have a highly significant effect on mill consumption of cotton. Inclusion of this factor, rough as it is, in the formulation of the demand equation for cotton increases considerably its validity and predictability.[20]

## Analysis IV—Same Period as Analysis III, Same Variables as Analysis II

To permit a direct comparison of the analyses run with and without the measure of imbalance in mill inventories, Analysis IV was run for the same years as Analysis III but in the same form and with the same variables as Analysis II. Results from Analysis IV are given in table 1. The regression equation was as follows:

$$\text{Log } X_1 = -1.34 + 1.05 \log X_2 + 1.15 \log X_3 - 0.12 \log X_4 - 0.27 \log X_5$$

By adding $X_6$ (actual deviations of the stock-unfilled order ratio for cloth from normal), the multiple coefficient of determination was raised from 0.84 to 0.95. Also, there was improvement in the partial correlation coefficients, and a substantial reduction in the standard error of estimate. The regression coefficients from Analysis IV, though uniformly higher, do not differ significantly in a statistical sense from those for Analysis III.

[20] One note of caution must be given. Application of the single-equation least-squares approach to this problem necessarily assumes that the independent variables used are "predetermined." This means that each of these variables is determined by forces in operation before the current time period, by factors outside the structure in question, or by both. As consumer income cannot be said to be significantly affected by changes in mill consumption of cotton and as synthetic consumption is based primarily on a trend factor, these variables may be deemed predetermined. In the case of the price of cotton and of the inventory imbalance measure, a lead of less than 1 year was used. As annual data were used, these variables may be only partly predetermined with respect to the given demand structure. If this is true, the regression coefficients given in the text may be biased. Two alternatives are possible. One is to run the analysis using semi-annual data and the other is to set up and solve a system of simultaneous equations. Work along both lines is in progress.

# Survey of Farm Slaughter of Hogs in North Carolina

By Jack Fleischer and Alva L. Finkner

*The study reported in the following paper was based on a survey conducted by the Institute of Statistics, North Carolina State College. The survey was designed to assist the Livestock and Poultry Statistics Branch of the Agricultural Estimates Division to isolate factors that may account for total disposition in their national balance sheet for hogs.*

DURING WORLD WAR II and thereafter, the Livestock and Poultry Statistics Branch of the Agricultural Estimates Division had difficulty in keeping the national balance sheet for hogs "in balance." As imports and exports of hogs are negligible, the beginning inventory plus farrowing, minus slaughter and other deaths, should equal the closing inventory. It was believed that estimates of hogs on hand, pigs farrowed, and part of the total slaughter—both federally and nonfederally inspected—were reliable, but that other items of disposition, mainly farm slaughter, were consistently underestimated. This belief was apparently sustained by the results of the study.

Two personal interview surveys were conducted during January and April 1953, with the universe defined as 16 counties in northeastern North Carolina. Each county was assigned to 1 of 3 geographic strata as follows:

| *Stratum I* | *Stratum II* | *Stratum III* |
|---|---|---|
| Greene | Edgecombe | Bertie |
| Johnston | Martin | Chowan |
| Lenoir | Nash | Gates |
| Wayne | Pitt | Halifax |
| | Wilson | Hertford |
| | | Northampton |
| | | Perquimans |

The surveys were planned in three stages covering 25 master sample segments located in 6 of the 16 counties: (1) An interview survey with approximately 200 respondents to cover the period from October 1 to December 31, 1952; (2) a follow-up mail survey of the same respondents immediately after the interview survey was completed; and (3) another interview survey with the same respondents in April to cover the period from January 1 to March 31, 1953.

The 3-point purpose of the survey was to:

Account for all hogs of a given respondent during a 3-month period by recording the inventories for the opening and closing periods and all possible sources of acquisition and disposition.

Compare results of identical questions asked of identical respondents by a mailed inquiry following a personal interview.

Evaluate a new sampling technique that involved selection from a given stratum of two primary sampling units with probability proportional to their combined sizes.

## Balance Sheet of Hogs

When the respondent answered questions concerning his balance sheet for hogs, the first answers he gave were recorded. If the balance sheet did not check he was asked later in the interview to give revised figures that would make it check. A study was made of these changes to see what effect they had on the various components of the balance sheet (table 1).

Evaluating the differences by "t" tests indicated no significance for supply and ending inventory, but the differences in disposition were significant at the 5-percent level. This significant underestimation in disposition amounts to 1.06 percent of the ending inventory. As the percentage of underestimation has been 2 to 6 percent during the last 8 years, the use of first answers for estimating may account for part of the overall underestimation. Revised answers resulted in an increase in ending inventory which amounts to 2.40 percent of ending inventory. Although this component is not significant, the total increase of 3.46 percent is close to the average underestimation for total hogs and pigs in the United States during the last 8 years.

The April survey failed to substantiate the

TABLE 1.—*Frequency distribution of changes in supply, disposition and ending inventory of individual balance sheets in the period October 1 to December 31, 1952*

| Difference (Balanced-first) answers | Supply [1] | | Disposition | | Ending inventory | |
|---|---|---|---|---|---|---|
| | Frequency [2] | Sum of difference | Frequency [2] | Sum of difference | Frequency [2] | Sum of difference |
| −21 | 1 | −21 | | | 0 | 0 |
| −15 | 0 | 0 | | | 1 | −15 |
| −11 | 1 | −11 | | | 0 | 0 |
| −8 | 1 | −8 | | | 0 | 0 |
| −6 | 0 | 0 | | | 1 | −6 |
| −3 | 1 | −3 | | | 2 | −6 |
| −2 | 1 | −2 | | | 0 | 0 |
| −1 | 3 | −3 | | | 2 | −2 |
| 0 | 137 | 0 | 158 | 0 | 149 | 0 |
| 1 | 5 | 5 | 3 | 3 | 3 | 3 |
| 2 | 4 | 8 | 0 | 0 | 1 | 2 |
| 3 | 5 | 15 | 1 | 3 | 1 | 3 |
| 4 | 2 | 8 | 0 | 0 | 2 | 8 |
| 5 | 3 | 15 | 1 | 5 | 0 | 0 |
| 6 | 1 | 6 | 0 | 0 | 0 | 0 |
| 8 | | | 2 | 16 | 0 | 0 |
| 9 | | | | | 1 | 9 |
| 30 | | | | | 1 | 30 |
| 35 | | | | | 1 | 35 |
| Sum | 165 | 9 | 165 | 27 | 165 | 61 |
| Mean | | 0. 0545 | | 0. 1636 | | 0. 3697 |

[1] Supply included beginning inventory October 1, 1952, plus acquisitions.

[2] Does not include reports that had no hogs during the 3-month period.

Agricultural Marketing Service and North Carolina State College Farm Slaughter Survey, January 1953.

underestimation in disposition and ending inventory. A possible explanation of the failure is that the respondents, having been interviewed in January, were on their guard in April and anticipated the questions; thus during the April survey they gave more correct answers the first time the questions were asked. There were 51 changes in supply, disposition, and ending inventory in January, and only 25 total changes for the same components in April.

Another survey, in which different farmers were interviewed, should have been conducted concurrently with the April survey in which the same respondents were revisited. This would have given us another measure of the differences between first and corrected answers, without the bias of the respondents who had been "educated" to the questions being asked.

Confidence limits on the estimated percentage of farmers who would have made changes in the January survey were 11 percent and 25 percent for supply, 1 percent and 9 percent for disposition, and 6 percent and 17 percent for ending inventory. These values were obtained from the binomial chart of Clopper and Pearson (1934).[1] The percentage of changes for the April survey were at the lower limits of these confidence intervals but, as previously explained, the circumstances of the respondents answering were not the same in both surveys.

## Comparison of Personal Interview With Mail Survey

The inquiry on "Disposition of Livestock During 1952" was mailed only to the farmers whose names and addresses were obtained on the personal interview schedules. This inquiry contained three questions, among others, that were identical with questions asked on the interview schedule. Out

[1] CLOPPER, C. J., and PEARSON, E. S. THE USE OF CONFIDENCE OR FIDUCIAL LIMITS ILLUSTRATED IN THE CASE OF BINOMIAL. Biometrika. 26: 404. 1934.

of the 172 mail inquiries (which correspond to the 172 farmers interviewed in the January survey) 18 responded within 2 weeks. Although this was more than 10 percent response, it was not enough for purposes of comparison. Therefore, a second request was mailed. The second request brought a response of 46 for a total of 64 schedules.

For the purpose of comparing the results of these two methods of obtaining data, we believed that 64 farmers would give enough information, and we did not want to irritate any of the mail nonrespondents with further requests as they were to be visited again in April (table 2).

Actually, three questions were compared, but two of them were on 1952 slaughter, one referring to hogs of more than 150 pounds butchered, the other to pigs of less than 150 pounds butchered. It was difficult to disassociate these two questions and in some instances differences in one question were offset by differences in the other. For a hog that weighed approximately 150 pounds, it would be hard for the farmer to say definitely that it belonged in one or the other category, so these answers were combined. Offsetting answers were recorded as no differences.

Making paired comparisons and evaluating by means of "t" tests indicated no significant differences in answers between the two methods of obtaining the data. The mean differences in table 3 and the 95-percent confidence limits are given.

| | |
|---|---|
| January 1 Inventory | 0.2419±1.3773 |
| 1952 Slaughter | 0.4603± .7101 |

TABLE 2.—*Number of hogs and pigs on farms and slaughtered, as given by personal interviews and mail inquiries to 64 farmers, 1952*

| Item | Answer given by— | | Difference [1] | |
|---|---|---|---|---|
| | Personal interview | Mail inquiry | Quantity | Percentage |
| | *Number* | *Number* | *Number* | *Percent* |
| Hogs and pigs: | | | | |
| Slaughtered in 1952 | 275 | 246 | 29 | 11.79 |
| On hand Jan. 1, 1953 | 629 | 614 | 15 | 2.44 |

[1] The numbers given by the mailed inquiry were used to compute these percentages because the Agricultural Estimates Division obtains estimates from its mail survey.

Agricultural Marketing Service and North Carolina State College Farm Slaughter Survey, January 1953.

TABLE 3.—*Frequency distribution of differences in number of hogs and pigs between personal interview and mail inquiries for 62 and 63 farms respectively*

| Difference enumeration—mail | Number of hogs and pigs | | | |
|---|---|---|---|---|
| | Slaughtered in 1952 | | On hand January 1, 1953 | |
| | Frequency | Sum of difference | Frequency | Sum of difference |
| −16 | ------- | ------- | 1 | −16 |
| −13 | ------- | ------- | 1 | −13 |
| −11 | ------- | ------- | 1 | −11 |
| −10 | ------- | ------- | 1 | −10 |
| −8 | ------- | ------- | 1 | −8 |
| −7 | ------- | ------- | 1 | −7 |
| −6 | ------- | ------- | 1 | −6 |
| −5 | ------- | ------- | 2 | −10 |
| −4 | 2 | −8 | 1 | −4 |
| −3 | 3 | −9 | 2 | −6 |
| −2 | 2 | −4 | 1 | −2 |
| −1 | 8 | −8 | 2 | −2 |
| 0 | 31 | 0 | 28 | 0 |
| 1 | 6 | 6 | 3 | 3 |
| 2 | 2 | 4 | 3 | 6 |
| 3 | 4 | 12 | 1 | 3 |
| 4 | 2 | 8 | 1 | 4 |
| 5 | 1 | 5 | 2 | 10 |
| 6 | 1 | 6 | 2 | 12 |
| 7 | 0 | 0 | 1 | 7 |
| 8 | 0 | 0 | 2 | 16 |
| 10 | 0 | 0 | 2 | 20 |
| 12 | 0 | 0 | 1 | 12 |
| 17 | 1 | 17 | 1 | 17 |
| Total | 63 | 29 | 62 | 15 |
| Mean differences | ------- | 0.4603 | ------- | 0.2419 |

Agricultural Marketing Service and North Carolina State College Farm Slaughter Survey, January 1953.

Confidence limits are also placed on $p$ (the true proportion of farmers answering differently by mail and personal visitation). Normal theory approximation is used in this instance as recommended by Cochran (p. 41).[2] The formula is

$$p \pm \left( t \sqrt{\frac{N-n}{N-1} \frac{pq}{n} + \frac{1}{2n}} \right)$$

where t is a value taken for a specified confidence level,

$N$ is the number in the population,
$n$ is the number in the sample,
and $q=1-p$.

[2] COCHRAN, W. G. SAMPLING TECHNIQUES. John Wiley and Sons, Inc., New York, 1953. Although not strictly applicable, sampling from a binomial type of population is assumed.

The finite correction factor $\left(\frac{N-n}{N-1}\right)$ is ignored in this case because the sample is less than 0.4 percent of the population. The 95-percent interval for the January 1 inventory is between 41.4 percent and 68.2 percent, and for 1952 slaughter, between 37.4 percent and 64.2 percent.

## Evaluation of the Sampling Technique

The theory for the selection of two primary sampling units from a stratum with probability proportional to their combined sizes is given by Sen.[3] To evaluate this sampling technique, estimates of various characteristics were made from an unbiased estimation equation.

$$Y'=\frac{Y'_i+Y'_k}{X_i+X_k}X$$

where

$Y'$ is the estimated total of a characteristic for the stratum

$Y'_i$ is the estimated total of the same characteristic in the i-th county

$X_i$ is the 1950 U. S. Census total for total number of hogs in the i-th county

$X$ is the stratum total number of hogs as given by the 1950 U. S. Census.

The variance of this estimate is given as

$$V(Y')=\sum_{i\neq j}\sum\frac{X}{2(N-1)}\frac{(Y_i+Y_j)^2}{X_i+X_j}-Y^2+\frac{1}{2}\sum_{i\neq j}\sum\frac{Z_i+Z_j}{(N-1)(X_i+X_j)}X$$

where $Z_i=M_i\ (M_i-m_i)\ \sigma_i^2/m_i$, N is the number of psu (primary sampling units) in a stratum, $Y_i$ is actual total of a characteristic in the i-th county, and $M_i$ and $m_i$ are the numbers of mss (master sample segments) in the i-th county, population and sample, respectively.

The results of computing estimates of various characteristics are presented in table 4, along with figures of the 1950 United States Census of Agriculture.

Variance formulas have been proposed for estimating the variance of a particular estimate $Y'$. The formula that Sen proposes resulted in negative estimates of variance in 2 of the 3 strata for number of farms, and therefore is not practical in this case. Research is being conducted at the North Carolina Institute of Statistics in this particular field. When practical estimates of variance are derived they will be applied to these data.

## Cost of Surveys

In the remaining space of this paper details of the cost of the two personal interview surveys are given and analyzed. The same areas were visited in each of the surveys, which were conducted by means of cluster sampling.

The schedule for the January survey consisted of 12 pages and contained 127 questions. For all farmers and for those nonfarmers who had hogs, 105 questions were applicable; for the nonfarmers who had no hogs, only 31 questions were applicable. These 31 questions are considered to represent a short form of the regular schedule. Several of the questions were asked all respondents, for screening purposes, regardless of whether they were farmers or had hogs. Schedules for January and April were similar except for the different periods covered by the questions.

Respondents were located in 25 master sample segments (mss) which were selected at random from 6 counties, which in turn had been selected from a universe of 16 counties. There were 207

TABLE 4.—*Estimates of various farm characteristics, 1950 and 1952*

| Item | 1950 [1] census of agriculture | Estimated January 1, 1953 | Difference between estimates and census | |
|---|---|---|---|---|
| | | | Quantity | Percentage |
| | *Number* | *Number* | *Number* | *Percent* |
| Farms | 59, 048 | 46, 175 | −12, 873 | 21. 80 |
| Acreage: | *Acres* | *Acres* | *Acres* | |
| Farms | 3, 775, 763 | 3, 849, 723 | 73, 960 | 1. 96 |
| Cropland | 1, 699, 956 | 1, 751, 632 | 51, 676 | 3. 04 |
| Hogs and pigs: | *Number* | *Number* | *Number* | |
| On farms | 488, 351 | 516, 570 | 28, 219 | 5. 78 |
| Slaughtered preceding year | 198, 235 | 212, 231 | 13, 996 | 7. 06 |

[1] U. S. Bureau of the Census, 1950 U. S. Census of Agriculture, Vol. 1, part 16. United States Government Printing Office, Washington, D. C., 1952.

Agricultural Marketing Service and North Carolina State College Farm Slaughter Survey, January 1953.

[3] SEN, A. R. FURTHER DEVELOPMENTS OF THE THEORY AND APPLICATION OF THE SELECTION OF PRIMARY SAMPLING UNITS, WITH SPECIAL REFERENCE TO THE NORTH CAROLINA AGRICULTURAL POPULATION. Unpublished Ph. D. Thesis. North Carolina State College, 1952.

TABLE 5.—*Cost of farm slaughter surveys by specified items and by enumerators, conducted in 6 northeastern counties in North Carolina, January and April 1953*

JANUARY AND APRIL SURVEYS

| Item | Schedules | Entire survey | | Training school | | Salary | | Travel | | Per diem | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | Per schedule | Total | Per schedule | Total | Per schedule | Total | Per schedule | Total | Per schedule |
| Enumerator: | *Number* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| 1 | 213 | 478. 45 | 2. 25 | 28. 00 | 0. 13 | 242. 25 | 1. 14 | 192. 90 | 0. 91 | 15. 30 | 0. 07 |
| 2 | 26 | 116. 01 | 4. 46 | 40. 58 | 1. 56 | 46. 00 | 1. 77 | 26. 88 | 1. 03 | 2. 55 | . 10 |
| 3 | 176 | 399. 52 | 2. 27 | 30. 01 | . 17 | 182. 75 | 1. 04 | 169. 54 | . 96 | 17. 22 | . 10 |
| Supervision | ------- | 3. 43 | . 01 | 3. 43 | . 01 | ------- | ------- | ------- | ------- | ------- | ------- |
| Total | 415 | 997. 41 | 2. 40 | 102. 02 | . 25 | 471. 00 | 1. 13 | 389. 32 | . 94 | 35. 07 | . 08 |
| | JANUARY SURVEY | | | | | | | | | | |
| Enumerator: | | | | | | | | | | | |
| 1 | 92 | 233. 27 | 2. 54 | 12. 09 | . 13 | 117. 50 | 1. 28 | 96. 72 | 1. 05 | 6. 96 | . 08 |
| 2 | 26 | 116. 01 | 4. 46 | 40. 58 | 1. 56 | 46. 00 | 1. 77 | 26. 88 | 1. 03 | 2. 55 | . 10 |
| 3 | 89 | 231. 86 | 2. 61 | 15. 18 | . 17 | 107. 25 | 1. 21 | 98. 56 | 1. 11 | 10. 87 | . 11 |
| Supervision | ------- | 1. 89 | . 01 | 1. 89 | . 01 | ------- | ------- | ------- | ------- | ------- | ------- |
| Total | 207 | 583. 03 | 2. 82 | 69. 74 | . 34 | 270. 75 | 1. 31 | 222. 16 | 1. 07 | 20. 38 | . 10 |
| | APRIL SURVEY | | | | | | | | | | |
| Enumerator: | | | | | | | | | | | |
| 1 | 121 | 245. 18 | 2. 03 | 15. 91 | . 13 | 124. 75 | 1. 03 | 96. 18 | . 79 | 8. 34 | . 07 |
| 2 | ------- | ------- | ------- | ------- | ------- | ------- | ------- | ------- | ------- | ------- | ------- |
| 3 | 87 | 167. 66 | 1. 93 | 14. 83 | . 17 | 75. 50 | . 87 | 70. 98 | . 82 | 6. 35 | . 07 |
| Supervision | ------- | 1. 54 | . 01 | 1. 54 | . 01 | ------- | ------- | ------- | ------- | ------- | ------- |
| Total | 208 | 414. 38 | 1. 99 | 32. 28 | . 16 | 200. 25 | . 96 | 167. 16 | . 80 | 14. 69 | . 07 |

Agricultural Marketing Service and North Carolina State College Farm Slaughter Surveys, January and April 1953.

and 208 respondents, respectively, in the January and April surveys, for an average of 8.3 respondents per mss.

Cluster sampling of this kind offers a large saving in time and money over list sampling, because, once the mss is located, the enumerator can obtain several interviews with little further expenditure of time and travel in finding each respondent on a list.

The average cost per schedule was $2.84 for the January survey, and for the revisits to the same respondents in April the average cost per schedule was $1.99. The training school cost $102.02. As only one training session was necessary for both surveys, the cost was distributed to both in proportion to the number of schedules obtained in each. Table 5 gives a breakdown of the costs of interviewing into training school, salary, travel, and per diem. Rate of pay for the training school was as follows:

(1) Salary of $1 an hour for the time spent in class;

(2) Bus fare from the home of the interviewer to the campus of North Carolina State College, Raleigh, and return, or 3½ cents a mile if any other mode of transportation was used;

(3) Actual per diem expenses, such as hotel and meals.

For the actual enumeration work, the rate of pay was as follows:

(1) Salary of $1 an hour from the time the interviewer left his home until he returned from interviewing, excluding any time spent at night in a hotel;

(2) Actual mileage at 7 cents a mile, which included travel from the home of the interviewer to the segment, and return;

(3) Actual per diem expenses, such as meals and telephone calls.

TABLE 6.—*Cost of interviews, excluding training school, for farm slaughter surveys by enumerators, conducted in 6 northeastern counties in North Carolina, January and April, 1953*

JANUARY AND APRIL SURVEYS

| Item | Schedules | Entire survey | | Interview | | Between interviews [1] | | Travel outside [2] segs and per diem | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total | Per school | Total | Per school | Total | Per school | Total | Per school |
| Enumerator: | *Number* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| 1 | 213 | 449. 95 | 2. 11 | 76. 89 | 0. 36 | 38. 62 | 0. 18 | 334. 44 | 1. 57 |
| 2 | 26 | 75. 93 | 2. 92 | 17. 58 | . 68 | 9. 71 | . 37 | 48. 14 | 1. 85 |
| 3 | 176 | 369. 51 | 2. 10 | 102. 64 | . 58 | 37. 38 | . 21 | 229. 49 | 1. 30 |
| Total | 415 | 895. 39 | 2. 16 | 197. 11 | . 47 | 85. 71 | . 21 | 612. 07 | 1. 48 |
| | JANUARY SURVEY | | | | | | | | |
| Enumerator: | | | | | | | | | |
| 1 | 92 | 220. 68 | 2. 40 | 39. 50 | . 43 | 19. 18 | . 21 | 162. 00 | 1. 76 |
| 2 | 26 | 75. 93 | 2. 92 | 17. 58 | . 68 | 9. 71 | . 37 | 48. 14 | 1. 85 |
| 3 | 89 | 216. 68 | 2. 44 | 59. 76 | . 67 | 20. 32 | . 23 | 136. 60 | 1. 54 |
| Total | 207 | 513. 29 | 2. 48 | 116. 84 | . 56 | 49. 21 | . 24 | 346. 74 | 1. 68 |
| | APRIL SURVEY | | | | | | | | |
| Enumerator: | | | | | | | | | |
| 1 | 121 | 229. 27 | 1. 89 | 37. 39 | . 31 | 19. 44 | . 16 | 172. 44 | 1. 43 |
| 2 | ------- | ------- | ------- | ------- | ------- | ------- | ------- | ------- | ------- |
| 3 | 87 | 152. 83 | 1. 76 | 42. 88 | . 49 | 17. 06 | . 20 | 92. 89 | 1. 07 |
| Total | 208 | 382. 10 | 1. 84 | 80. 27 | . 39 | 36. 50 | . 18 | 265. 33 | 1. 28 |

[1] Includes travel between interviews within the segment and salary for time spent for traveling between interviews.

[2] Includes salary for time spent traveling from point of origin to segments and returns, for time spent traveling between segment and corresponding travel expenses.

Agricultural Marketing Service and North Carolina State College Farm Slaughter Surveys, January and April 1953.

## Further Breakdown of Costs

Excluding the cost of the training school, table 6 gives a breakdown, by survey, of the cost of obtaining the interview, the cost of travel between interviews within a segment, and the cost of travel outside the segment, plus per diem. The per diem costs are included with travel outside the segment because these costs are inversely proportional to each other. If an interviewer stayed in a hotel near a segment his per diem was greater, but he saved the time and mileage that he would otherwise have taken to travel the distance to his home and back.

The cost of obtaining the interview is made up of the time, at $1 an hour, actually spent for the interview as recorded in the appropriate space on the heading of the schedule. Also included is salary for time spent in making corrections to schedules already taken. "Between interview" cost is made up of the time, at $1 an hour plus mileage at 7 cents a mile, that it took the interviewer to get from one respondent to the next. Time spent between interviews necessarily includes the cost of calling on people who were not at home, for whom no schedule was obtained until the second or third call. "Callbacks" are what makes this component a substantial part of the entire cost. Travel outside the segment includes salary for the time spent getting to the segment from the home of the interviewer and return, travel from segment to segment, travel to nearby towns for meals, and mileage for this travel.

A cost function that could be applied to these surveys is:

$$C=a+bn+cn+dn$$

where $C$=Total cost of both surveys.
$a$=Training school cost.
$b$=Interviewing cost per schedule.
$c$=Between interview cost per schedule.
$d$=Travel outside segment and per diem per schedule.
$n$=Number of interviews.

The cost function in this case would be $997.41=102.02+(0.47)n+(0.21)n+(1.48)n$

where the first 2 amounts appear in table 5 and the rest are in table 6.

## Time and Cost for Actual Interview

As there were two types of respondents—(1) nonfarmers with hogs and all farmers and (2) nonfarmers with no hogs—the length of time spent in obtaining the regular 12-page schedule and the short 3-page schedule varied. Table 7 breaks down the interview costs of obtaining both types of schedules. Actual minutes spent in obtaining complete interviews were recorded. Average time as well as cost is given.

## Further Comparisons

The agreement between enumerators 1 and 3 in terms of cost per schedule is interesting—the difference between the two for the average of both surveys was only 2 cents per schedule.

On the average, enumerator 3 spent more time per schedule but traveled less than interviewer 1. These observations were consistent for both surveys. Enumerator 2, who had to move unexpectedly after the survey began, showed a higher cost per schedule on the 26 interviews taken. The comparison looks somewhat more favorable for enumerator 2 if the training school costs are removed from consideration, but the cost remains higher than for the other two. The difference between 2 and the others, ignoring costs of training school, is primarily in salary. This difference may be accounted for partly by the average length of time actually spent in interviewing (table 3).

The cost function as given previously $C=a+bn+cn+dn$ where, in this survey (table 6) $b=0.47$, $c=0.21$, $d=1.48$.

It should be emphasized that these coefficients are not constants but might vary from survey to survey. Thus they would be applicable for planning purposes only when conducting a similar survey or repeating the same type of survey. Of course, the value of all coefficients depends upon the specified salary and mileage rates.

The quantity, $a$, depends upon three factors: Time spent in training, number of interviewers, and distance interviewers must travel to attend the training school. It should be possible to estimate these items rather closely for any given survey. The $b$ coefficient is the salary for the time spent in actual conversation with the respondent.

TABLE 7.—*Time spent and cost in obtaining short and regular size schedules, by enumerator, from farm slaughter surveys, January and April 1953, conducted in 6 northeastern North Carolina counties*

| Item | Schedules | Time | | Cost | |
|---|---|---|---|---|---|
| | | Total | Average per schedule | Total | Average per schedule |
| | JANUARY SHORT SCHEDULE | | | | |
| Enumerator: | *Number* | *Minutes* | *Minutes* | *Dollars* | *Dollars* |
| 1 | 13 | 248 | 19. 1 | 4. 13 | 0. 32 |
| 2 | 2 | 90 | 45. 0 | 1. 50 | . 75 |
| 3 | 11 | 340 | 30. 9 | 5. 67 | . 52 |
| Total | 26 | 678 | 26. 1 | 11. 30 | . 43 |
| | JANUARY REGULAR SCHEDULE | | | | |
| Enumerator: | | | | | |
| 1 | 79 | 2, 122 | 26. 9 | 35. 37 | . 45 |
| 2 | 24 | 965 | 40. 2 | 16. 08 | . 67 |
| 3 | 78 | 3, 245 | 41. 6 | 54. 09 | . 69 |
| Total | 181 | 6, 332 | 35. 0 | 105. 54 | . 58 |
| | APRIL SHORT SCHEDULE | | | | |
| Enumerator: | | | | | |
| 1 | 16 | 203 | 12. 7 | 3. 38 | . 21 |
| 2 | | | | | |
| 3 | 22 | 530 | 24. 1 | 8. 83 | . 40 |
| Total | 38 | 733 | 19. 3 | 12. 21 | . 32 |
| | APRIL REGULAR SCHEDULE | | | | |
| Enumerator: | | | | | |
| 1 | 105 | 2, 041 | 19. 4 | 34. 01 | . 32 |
| 2 | | | | | |
| 3 | 65 | 2, 043 | 31. 4 | 34. 05 | . 52 |
| Total | 170 | 4, 084 | 24. 0 | 68. 06 | . 40 |

This value can also be considered to have two components: (1) Time necessary to explain the objectives of the survey and establish rapport, and (2) time required to ask specific questions and to record respondents' answers. Evidence that both of these components exist is given in table 7.

Although 31 questions were listed on the short schedule, an average of only 18 were asked per respondent, because of the inapplicability of some questions. Similarly, of the 105 possible questions on the regular schedule, an average of 68 were asked. Thus, almost 4 times as many questions were asked on the regular schedule yet it took only 35 percent longer to administer, on the average. It is evident that information from the additional questions was obtained at little extra cost. The shorter interview time in April probably reflects both the enumerator's increased skill due to practice and the fact that less explanation to the respondent was necessary.

The $c$ is the cost of traveling between farms within a segment; it includes both mileage and salary. This factor would presumably be subject only to differences between enumerators and segment sizes. The value of 0.21 might be considered as the best estimate of this travel cost per schedule for the area surveyed. The cost of "call backs" is included in this item. Of course, the $c$ term is applicable only to an area sampling design. The coefficient, $d$, is the cost of travel to the segment and includes per diem rates. This factor would seem to be a function of the sample size. Jessen (1942)[4] considers that, in Iowa, the total distance traveled in a given survey is proportional to the square root of the sample size. It is doubtful that this relationship holds in North Carolina.

It is well known that probability area or cluster sampling represents a considerable saving in cost over probability list sampling. A comparison of the cost of this survey with a list sample [5] having approximately the same sampling rate, the same salary rate, and the same length and complexity of schedule, further substantiates this premise. The comparable costs per schedule with training school costs excluded are given in table 8. Also excluded are the lower costs of the April survey as farmers enumerated in April had been identified and visited in January.

The major difference is undoubtedly in the cost of travel involved in locating the sampling units. In both surveys, the salary cost includes the time spent in traveling to the unit. In these 2 surveys average cost was at least 3 times as much to locate and identify a farm from a list sample as from an area sample.

TABLE 8.—*Average cost per schedule for farm slaughter and farm machinery surveys, by area and list-sampling*

| Item | Area survey—Farm slaughter, 1953 | List-survey—Farm machinery, 1951 |
|---|---|---|
| Cost: | *Dollars* | *Dollars* |
| Salary | 1. 31 | 2. 91 |
| Mileage | 1. 07 | 3. 10 |
| Meals per diem | . 10 | . 38 |
| Total | 2. 48 | 6. 39 |
| | *Number* | *Number* |
| Respondents | 207 | 486 |

Agricultural Marketing Service and North Carolina State College Farm Slaughter Survey, January and April 1953.

An additional table (table 9) is given which reflects the number of hours and the miles traveled. This information may be of value in comparing this survey with others with respect to these specific items.

For the January survey, the average time per schedule is almost 1½ hours, while for the April survey, the average time per schedule is only a little over 1 hour. The enumerators had to travel 4.18 miles more per schedule to complete the first survey than to complete the second. Only an average of 5.4 schedules per 8-hour day was completed during the January survey compared to 7.7 schedules per 8-hour day during the April survey.

## Conclusions

Memory bias may have been a factor in obtaining significant differences in disposition between balanced and first answers on the individual balance sheets. That the confidence limits on the mean difference encompass only positive values indicates that an underestimation exists. The discrepancies for all items of the balance sheet obtained by subtracting first answers from balanced

[4] STATISTICAL INVESTIGATION OF A SAMPLE SURVEY FOR OBTAINING FARM FACTS. Iowa Agr. Expt. Sta. Res. Bull.

[5] KASTENBAUM. A SAMPLE OF NONRESPONDENTS TO A MAILED INQUIRY ON FARM MACHINERY, HARVESTING METHODS, AND STRAWSAVING PRACTICES. Progress Report No. 10, March 1951. Institute of Statistics. North Carolina State College.

TABLE 9.—*Hours per schedule, miles traveled per schedule and number of schedules per 8-hour day, by enumerator, by survey of farm slaughter surveys, conducted in January and April 1953 in 6 northeastern North Carolina counties*

| Item | Schedules | Hours | | | | Miles traveled | | | | Schedules per 8-hour day |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Training school | Interviewing and travel | Total | Per schedule | Training school | Interviewing | Total | Per schedule | |
| Enumerator: | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| 1 | 213 | 16 | 242 | 258 | 1. 21 | 144 | 2, 756 | 2, 900 | 13. 62 | 6. 6 |
| 2 | 26 | 20 | 46 | 66 | 2. 54 | 84 | 384 | 468 | 18. 00 | 3. 1 |
| 3 | 176 | 16 | 183 | 199 | 1. 13 | 150 | 2, 422 | 2, 572 | 14. 61 | 7. 1 |
| Total | 415 | 52 | 471 | 523 | 1. 26 | 378 | 5, 562 | 5, 940 | 14. 31 | 6. 3 |
| JANUARY SURVEY | | | | | | | | | | |
| Enumerator: | | | | | | | | | | |
| 1 | 92 | 7 | 118 | 125 | 1. 36 | 62 | 1, 382 | 1, 444 | 15. 70 | 5. 9 |
| 2 | 26 | 20 | 46 | 66 | 2. 54 | 84 | 384 | 468 | 18. 00 | 3. 1 |
| 3 | 89 | 8 | 107 | 115 | 1. 29 | 76 | 1, 408 | 1, 484 | 16. 67 | 6. 2 |
| Total | 207 | 35 | 271 | 306 | 1. 48 | 222 | 3, 174 | 3, 396 | 16. 41 | 5. 4 |
| APRIL SURVEY | | | | | | | | | | |
| Enumerator: | | | | | | | | | | |
| 1 | 121 | 9 | 125 | 134 | 1. 11 | 82 | 1, 374 | 1, 456 | 12. 03 | 7. 2 |
| 2 | | | | | | | | | | |
| 3 | 87 | 8 | 75 | 83 | . 95 | 74 | 1, 014 | 1, 088 | 12. 51 | 8. 4 |
| Total | 208 | [1] 17 | 200 | 217 | 1. 04 | [1] 156 | 2, 388 | 2, 544 | 12. 23 | 7. 7 |

[1] Training school hours and miles are allocated to both surveys in proportion to the number of schedules obtained in each, although the actual training session preceded the January survey.

Agricultural Marketing Service and North Carolina State College Farm Slaughter Survey, January and April 1953.

answers resulted in net positive changes, indicating that net errors in answers were errors of omission and underestimation by the farmer. For ending inventory, the net discrepancy is relatively large and may be a major part of the underestimation. The changes in disposition and ending inventory were 3.46 percent of the corrected ending inventory. Although only the disposition changes of 1.06 percent were significant, the other 2.40 percent is the best estimate available of underestimation in ending inventory.

No significant difference between the answers by personal interview and mail inquiry was found. However, it should be remembered that this statement is based on the results of the test in which mail schedules followed personal interview only.

The many changes in answers between the personal interviews and mail inquiries indicate confusion on the part of respondents as to the implications of the questions. The questions should be reworded to avoid ambiguity; the inquiry on disposition should be mailed out more often than once a year, preferably every 3 months; and the respondent should be asked to record his answers by the month. We believe that this would reflect more accurate results than we get from the method now used.

With the sampling technique of selecting 2 psu's per stratum with probability proportional to their combined sizes, all estimations were reasonable except that of number of farms. The estimate of number of farms was not adjusted for farms in urban and rural places, which, together with the possible difference in the definition of a farm, may account for much of the 22 percent underestimation in the January survey.

# Selection and Use of Survival Ratios in Population Studies

By Everett S. Lee and Gladys K. Bowles

*Assumptions underlying use of survival ratios in population studies have been examined repeatedly, but some uncertainty remains as to the best ratio for specific problems and as to the advisability of attempting to correct ratios for variations in mortality, in racial or ethnic composition, in rural-urban residence, and in other categories or classifications. In separate research projects,[1] and in collaboration, the authors and their colleagues[2] used survival ratios to estimate migration for various areas and residence groups and in computing replacement ratios for rural-farm males of working age. In this article the authors report results of their explorations during the course of this work.*

IN SEVERAL TYPES of population analyses it is necessary to estimate the survivors of a given population group at the end of a specified period. This is usually done by applying survival ratios to specified groups or subdivisions of the population at the beginning of a period. Survival ratios in the main reflect mortality. They are commonly developed from life tables or by relating the population of a specified age group counted in one decennial census to the population counted in a group 10 years younger in the preceding census. The two types of ratios, generally labeled life table and census survival ratios, respectively, have application in specific types of population studies.

For approximately closed populations, census survival ratios tend to yield more reliable estimates of net migration than life table survival ratios, as Hamilton, Henderson, Price, Siegel, and others[3] have demonstrated, and these ratios have been used in our historical migration studies. In other problems, such as the making of current estimates or projections, life table ratios were used.[4] For example, in estimating entrants into and departures from the working-age group of rural farm males (defined as 25–69), we computed survivors to 1960 of males aged 15 to 24 in 1950, and deaths during the decade of males aged 25 to 59. We considered using 1940–50 census survival ratios but abandoned the idea because of changing mortality, changing patterns of misenumeration from census to census, and the apparently heavier underenumeration in 1940 than in 1950. Instead of 1940–50 census survival ratios, we used life table ratios based on a projection of 1950 ratios under a medium assumption of mortality. For some areas ratios resulting from high and low assumptions were applied also.

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[1] Lee, Everett S. net intercensal migration, 1870–1940. Vol. I. introduction and summary tables. Univ. of Penn. Studies of Population Redistribution and Economic Growth, 1953. (Unpublished.)

U. S. Agricultural Marketing Service and U. S. Bureau of the Census. replacement ratios and rates of rural farm males of working ages, 1950–60. (In process.)

U. S. Agricultural Marketing Service. net migration from the farm population, 1940–50. (In process.)

[2] Especially Helen R. White, formerly with the U. S. Department of Agriculture, and Anne S. Lee, University of Pennsylvania.

[3] Hamilton, C. Horace, and Henderson, F. M. use of survival rate method in measuring net migration. Jour. Amer. Statis. Assoc. 39 (226) : 197–206. 1944.

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[4] National Resources Committee. population statistics—2. state data (U. S. and State Life Tables, 1929–31). 1937.

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In deciding which ratios to use in various problems and the methods of application, we made several investigations, six of which are selected for discussion in this paper: (1) Differences in mortality among States; (2) differences in life table survival ratios between native and foreign-born whites; (3) comparison of estimated State life table survival ratios with actual State life table ratios; (4) differences in estimates of net migration resulting from use of "forward," "average," and "reverse" survival ratios; (5) differences obtained in estimated survivors when broad age groups instead of narrow ones were used; and (6) results obtained from using different assumptions about mortality.

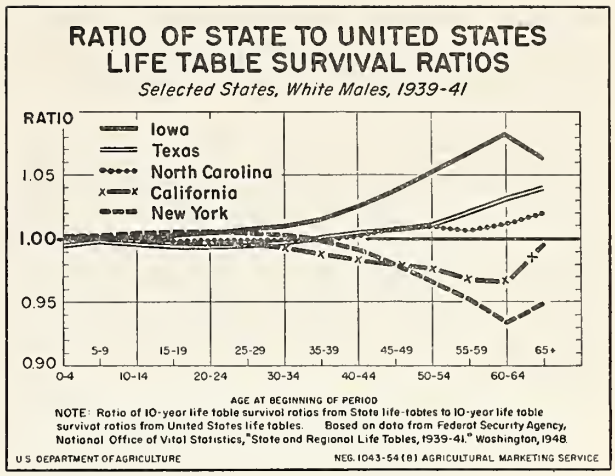


FIGURE 1.

## Differences in Survival Among the States

To examine State differences in survival, we constructed 10-year survival ratios for each 5-year age-sex group from 0–4 through 60–64, and for the group 65 and over at the beginning of the decade from State and national life tables for whites for 1929–31 and 1939–41. Ratios for the States were then compared with those for the United States, age group by age group. Comparisons for 1939–41 for males are shown in figure 1.

For younger ages, variation from the national average was usually slight; but after age 35–39, differences widened in most States; for the upper age groups they become rather large. In 1939–41 no group of either sex below age 25 at the beginning of the decade differed from the national survival ratio by as much as 2 percent. Among 47 of the 48 States and the District of Columbia, the difference for females was less than 1 percent for all ages below 40 at the beginning of the decade. Not until ages 45–49 for males and 55–59 for females were there States in which the ratios were as much as 5 percent greater or less than the United States ratio. In only one State did a survival ratio for each sex for an age group differ as much as 10 percent from the national average.

State ratios for females varied much less from the national average than did those for males. No State ratio for females through age group 40–44 at the beginning of the decade differed by 2 percent or more from the ratio for the United States. But nine States had male survival ratios in this age range that differed from the national average by 2 percent. For females, of the 686 State ratios—14 age groups for each State and the District of Columbia—498 were within 1 percent of the United States ratio. For males, only 437 of the State ratios fell in this category. In some States survival ratios were higher than the United States ratio for one sex, lower for the other. In California, for example, the survival ratios (1939–41) for males were lower than the United States ratio, especially for the older age groups. The ratios were approximately equal to or higher than the United States ratios for young and middle-aged females and were considerably higher for the older ages.

To show how State ratios departed from the national average States are grouped into the *five* following patterns for 1939–41. Most of the States fall into one of these groups. (Our discussion refers to the white male population; patterns for females are highly similar, although they deviate somewhat less from the United States ratio.)

(1) In the first group of States the deviations from the United States ratio are small, not exceeding 2 percent in any age group except for the age group 65 and over at the beginning of the decade. This group comprises 11 States, 3 in New England (Maine, New Hampshire, Vermont), four in the South Atlantic Division (Delaware, Georgia, North Carolina, Virginia), two in the East North Central Division (Ohio, Michigan), and one each in the East South Central and Mountain States (Alabama, Montana). Montana had no age group among males in which variation from the United States ratio was as much as 1 percent. In

certain other States, small deviations occurred in all except one or two age groups. Almost always the 65-years-and-over group deviated most from the United States ratio.

(2) Ratios for six States were higher than United States ratios at all ages, the difference increasing rather sharply after age 30 or so. Five of the States of the West North Central Division fell in this group, together with the neighboring State of Wisconsin. Most of these States were characterized by a high proportion of rural population.

(3) Five widely separated States—Georgia, Arizona, Louisiana, Nevada, and California—had lower ratios than those of the United States at all ages with the difference increasing for ages above 30 to 34 years.

(4) For a contiguous block of southern New England and Middle Atlantic States—Connecticut, New Hampshire, Massachusetts, Rhode Island, New Jersey, New York, and Pennsylvania, the neighboring State of Maryland, and the District of Columbia—the State ratios were higher than the national average up to about age 25 or 35, and then usually fell increasingly below the United States ratio as age increased. All these are highly urban States and have a high proportion of foreign-born whites.

(5) In another group of States, in the South and West most of the ratios are below the national average for the younger age groups, but for the middle and upper age groups the State ratios are higher than that of the United States, the difference increasing with age. These States are Florida, West Virginia, Tennessee, Arkansas, Oklahoma, Texas, Colorado, Idaho, New Mexico, Utah, Oregon, and Washington. For the most part they have a large proportion of rural population.

For 1929–31, deviations of State ratios are not presented in this paper, but they were much greater than for 1939–41. In contrast to 437 of 686 State ratios for males that were within 1 percent of the national average in 1939–41, only 369 of 672 [5] fell in this category for 1929–31. Female ratios tended to be closer to the national average, with 443 of 672 [5] differing from United States ratios by less than 1 percent. As in 1939–41 deviations were relatively small for the younger age groups and large for older age groups. States which had high ratios in the later period generally had high survival ratios in 1929–31.

Examination of State survival ratios could not be pushed back to a period earlier than 1929–31 because a much smaller number of States had life tables for earlier periods, and the only "national" life tables that exist cover varying aggregates of States. But through examination of survival ratios from 24 State life tables for 1919–20, we were able to confirm the impression gathered from the later life tables that differences in survival among the States tend to diminish with time.

## Survival Ratios for Native and Foreign-Born Whites

Several States that had markedly low survival ratios for middle and upper age groups had a large proportion of urban population, or of foreign-born white, or of both. Most life tables for the United States and the States are based on total white population. To examine the commonly held assumption that foreign-born survival ratios are lower than those for native whites we constructed life tables for native whites and foreign-born whites for 1900–10, 1910–20, 1920–30, and 1930–40. These life tables were admittedly crude; no adjustments were made of population or mortality data, and they were based on the age-specific mortality rates of census years. For example, the 1900–10 table was based on the average of the mortality rates for 1900 and 1910.

But it was found that for the younger ages there was little difference between the two, and in several instances foreign-born ratios were larger than those for native whites, particularly for 1900–10. After group 30–34 at the beginning and group 40–44 at the end of the 10-year period, ratios for foreign born were markedly lower than those for native born. The greatest difference is observed in 1900–10 and at each later period the difference decreased (fig. 2).

## Adjustment of National Life Table Survival Ratios

Often neither life table nor census data are available for a specific group for which survival ratios are required. In some instances, national survival ratios can be adjusted to account for variation in survival known or thought to exist

[5] Life tables for Texas are not available for 1929–31.

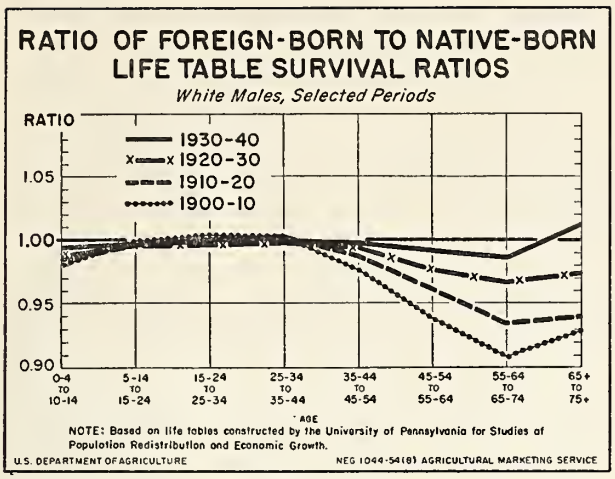


FIGURE 2.

between the national and a smaller group. For example, national survival ratios are sometimes adjusted for the State variations in survival discussed in the previous section.

We made a rough test of the effects of adjusting national survival ratios for State differences in survival. Estimates of the 10-year survival ratios for the States in 1939–41 were made by applying to the 1939–41 United States life table ratios adjustments based on differences between life table survival ratios for the United States and the States in 1929–31. Percentage differences between estimated survival ratios and actual ratios obtained from State life tables were computed when (1) no adjustment was attempted and the national life table ratios were used for the States; (2) adjustments representing the arithmetic difference between the 1929–31 State and national life table ratios were applied to 1939–41 national life table ratios; and (3) the ratios between 1929–31 State and national life table survival ratios were applied to the 1939–41 national life table survival ratios.

This was done for 20 States. For South Dakota and Arizona, States with the highest and lowest expectation of life at birth in 1930, and for New York, a State with medium life expectancy, results are shown in table 1. When no adjustment was made, the ratios were always too high for Arizona and too low for South Dakota. For some age groups, adjustments produced greater errors and for other age groups smaller errors than when no adjustments were made. Overcorrection is evident in many cases where the signs of the percentage errors change when the adjustments were made. Generally speaking, the results were better for the younger age groups when no adjustment was made. For the middle and upper age groups, adjustments improved the correspondence with survival ratios computed from the 1939–41 State life tables for some States, but not for others. In view of these results the desirability of introducing such adjustments may be questioned. They were not made in computing replacement ratios for rural-farm males of working age. An influential factor in the decision not to make this adjustment for State variation in survival was the convergence over time of the survival ratios of the States, as was pointed out in a previous section.

## Forward, Reverse, and Average Survival Ratios

Census survival ratios can be computed by three different methods. These are usually designated as "forward," "reverse," and "average." A forward census survival ratio is a fraction in which the numerator is the number of persons in an age-sex group of a closed population (one which is entered only by birth and left only by death) at a given census, and the denominator is the number 10 years younger at the preceding census. A reverse ratio, on the other hand, is obtained by inverting the fraction. The numerator is the number of persons in an age-sex group at a given census, and the denominator is the number 10 years older in the following census. Average ratios are obtained by combining the forward and the reverse ratios.

We experimented with reverse and average, as well as forward survival ratios. An example of our results (table 2) shows the percentage difference in the estimates of net migration for males for California and Vermont obtained by using the various types of survival ratios. For all age groups in California, net in-migration was indicated by all three methods; for all age groups in Vermont, net out-migration was estimated. The reverse method gave larger estimates of net in- or out-migration at any age than the forward method. The average method gave intermediate results. Differences in net migration using the three ratios are most striking for the oldest age groups. Theoretically, it may be better to use forward survival ratios for some States, average survival ratios for others, and reverse survival ratios for still others, but the extra work involved in using different types of ratios is not warranted by differ-

TABLE 1.—*Difference between estimated State life table survival ratios and actual State life table survival ratios [1] white males, selected States [2]*

| Age group | | Arizona | | | New York | | | South Dakota | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Difference between actual and ratio estimated from national ratio with— | | | Difference between actual and ratio estimated from national ratio with— | | | Difference between actual and ratio estimated from national ratio with— | | |
| 1940 | 1950 | No adjustment [3] | Arithmetic adjustment [4] | Ratio adjustment [5] | No adjustment [3] | Arithmetic adjustment [4] | Ratio adjustment [5] | No adjustment [3] | Arithmetic adjustment [4] | Ratio adjustment [5] |
| *Years* | *Years* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 0–4 | 10–14 | 0.62 | −1.54 | −1.56 | −0.23 | −0.30 | −0.30 | −0.16 | 0.54 | 0.54 |
| 5–9 | 15–19 | .25 | −.99 | −1.00 | −.19 | −.23 | −.23 | −.08 | .17 | .17 |
| 10–14 | 20–24 | .83 | −1.52 | −1.54 | −.35 | −.22 | −.21 | −.08 | .58 | .58 |
| 15–19 | 25–29 | 1.27 | −2.97 | −3.01 | −.48 | −.24 | −.24 | −.21 | .78 | .79 |
| 20–24 | 30–34 | 1.49 | −5.26 | −5.35 | −.47 | −.29 | −.29 | −.51 | .50 | .51 |
| 25–29 | 35–39 | 2.12 | −6.79 | −6.92 | −.36 | −.43 | −.43 | −.76 | .40 | .42 |
| 30–34 | 40–44 | 3.07 | −6.13 | −6.27 | −.18 | −.66 | −.67 | −1.08 | .91 | .94 |
| 35–39 | 45–49 | 4.03 | −4.01 | −4.14 | .23 | −.97 | −.99 | −1.76 | 1.54 | 1.59 |
| 40–44 | 50–54 | 4.92 | −2.28 | −2.38 | .95 | −1.42 | −1.45 | −2.92 | 1.82 | 1.89 |
| 45–49 | 55–59 | 4.79 | −2.34 | −2.41 | 1.99 | −2.00 | −2.04 | −4.30 | 1.69 | 1.75 |
| 50–54 | 60–64 | 3.88 | −3.24 | −3.29 | 3.37 | −2.41 | −2.45 | −5.86 | .61 | .66 |
| 55–59 | 65–69 | 3.30 | −4.02 | −4.11 | 5.19 | −2.03 | −2.12 | −7.30 | −.68 | −.60 |
| 60–64 | 70–74 | 3.43 | −4.45 | −4.60 | 7.11 | −.81 | −.97 | −7.95 | .51 | .68 |
| 65+ | 75+ | 1.75 | −.91 | −.96 | 5.34 | −1.94 | −2.08 | −6.84 | 2.17 | 2.34 |

[1] Basic data for the estimated and actual State life table survival ratios are from FEDERAL SECURITY AGENCY, NATIONAL OFFICE OF VITAL STATISTICS, STATE AND REGIONAL LIFE TABLES, 1939–41, and NATIONAL RESOURCES COMMITTEE, POPULATION STATISTICS—2. STATE DATA. Washington, D. C., 1948 and 1937, respectively.

[2] The three States above were selected for illustration on the basis of expectation of life at birth for white males in 1929–31. Arizona with 48.08 years, South Dakota with 64.38 years, were lowest and highest in expectation of life, respectively, and New York with 57.84 years was about midway between these two extremes.

[3] Estimated by assuming the 1939–41 United States survival ratio to be the same as the 1939–41 State survival ratio.

[4] Estimated by adding the difference between the 1929–31 United States survival ratio and the 1929–31 State survival ratio to the 1939–41 United States survival ratio.

[5] Estimated by multiplying the 1939–41 United States survival ratio by the ratio of the 1929–31 State survival ratio to the 1929–31 United States survival ratio.

ences obtained. Furthermore, intelligent choice of different ratios for different States presumes *a priori* knowledge of migration patterns in the States.

## Age Groupings and Mortality Assumptions

We also explored the effect of using survival ratios applied to different age groupings. In computing replacement ratios—ratio of number of *entrants* into selected working ages per 100 *departures* through death or retirement from these ages during a specified decade—we applied survival ratios computed for broad, modified broad, and detailed (5-year) age groups. For the working age group 25–69, survival ratios for the following groups were developed: *Broad age groups*—15–24 and 25–59; *Modified broad age groups*—15–24, 25–44, and 45–59; *Detailed age groups*—each 5-year age group 15–19 through 55–59.

Differences in replacement ratios from almost none to nearly 8 percent were observed among the various age groupings among the experimental areas. Some of these are shown in table 3. The determining factor in the resulting estimation of entrants and departures that form the ratio is the age structure of the rural-farm male population, particularly among the older ages, where the differential in survival changes markedly from age group to age group. In North Carolina, for example, 41,619 entrants and 18,536 departures were obtained by using the detailed age grouping, and 41,576 entrants and 19,480 departures were obtained using the broad age groups. The percentage difference in the resulting replacement

ratios was 5.3. As some differences as large as 8 percent were obtained, we decided to use a detailed age breakdown throughout computations of the replacement ratios.

In connection with the replacement ratios project, we observed variation in the ratios when survival ratios assuming different levels of mortality for the 1950–60 decade were used. Survival ratios to the midpoint of the decade were developed by assuming that average annual rates of decrease in 5-year death rates between 1939–41 and 1950 would prevail for 1950–60. We used two times this medium rate for the high assumption and half of it for the low. The high, medium, and low ratios were applied to detailed age data for rural farm males of all States. New Hampshire, a State with low replacement ratio 1940–50; Iowa, a State with medium replacement ratio 1940–50; and North Carolina, a State with high replacement ratio 1940–50, were chosen for illustration in table 3. Replacement ratios ranged from no appreciable difference to a difference of 4 percent when medium and high mortality levels were assumed. Between medium and low assumptions the range was from almost 2 percent to about 10 percent.

TABLE 2.—*Difference between estimates of net migration of white males using average and reverse census survival ratios from estimates using forward census survival ratios, selected States, 1930–40* [1]

| Age group | | California | | Vermont | |
|---|---|---|---|---|---|
| | | Difference between forward and— | | Difference between forward and— | |
| 1930 | 1940 | Average | Reverse | Average | Reverse |
| *Years* | *Years* | *Percent* | *Percent* | *Percent* | *Percent* |
| 0–4 | 10–14 | 0. 88 | 1. 76 | 0. 91 | 1. 66 |
| 5–9 | 15–19 | 1. 44 | 2. 88 | 1. 44 | 2. 89 |
| 10–14 | 20–24 | 3. 10 | 6. 19 | 3. 09 | 6. 17 |
| 15–19 | 25–29 | 2. 67 | 5. 34 | 2. 65 | 5. 35 |
| 20–24 | 30–34 | 1. 75 | 3. 50 | 1. 75 | 3. 50 |
| 25–29 | 35–39 | . 39 | . 78 | . 33 | . 65 |
| 30–34 | 40–44 | 1. 27 | 2. 53 | 1. 48 | 2. 66 |
| 35–39 | 45–49 | 4. 39 | 8. 78 | 4. 00 | 8. 00 |
| 40–44 | 50–54 | 4. 13 | 8. 26 | 4. 76 | 7. 94 |
| 45–49 | 55–59 | 8. 89 | 17. 79 | 8. 00 | 18. 00 |
| 50–54 | 60–64 | 13. 23 | 26. 45 | 13. 54 | 26. 04 |
| 55–59 | 65–69 | 13. 70 | 27. 40 | 13. 60 | 27. 45 |
| 60–64 | 70–74 | 24. 90 | 49. 80 | 24. 74 | 50. 00 |
| 65+ | 75+ | 83. 94 | 167. 89 | 83. 87 | 167. 94 |
| All ages | | 3. 90 | 7. 81 | 10. 03 | 20. 08 |

[1] Based on data from 1940 and 1950 Censuses of Population.

TABLE 3.—*Replacement ratios* [1] *for rural-farm working-age males, using specified age groups and different mortality assumptions, selected States, 1950–60*

| State and color | Replacement ratios based on— | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A. Age groups | | | | | B. Mortality assumptions | | | |
| | Broad | Modified | 5-year | Percentage difference between 5-year and— | | High | Medium | Low | Percentage difference between medium and— | |
| | | | | Broad | Modified | | | | High | Low |
| | | | | *Percent* | *Percent* | | | | *Percent* | *Percent* |
| New Hampshire | 95 | 94 | 93 | 2. 2 | 1. 1 | 94 | 95 | 97 | −1. 1 | 2. 1 |
| Iowa | 132 | 133 | 133 | −. 8 | 0 | 135 | 136 | 140 | −. 7 | 2. 9 |
| North Carolina: | | | | | | | | | | |
| White | 168 | 171 | 172 | −2. 3 | −. 6 | 174 | 176 | 180 | −1. 1 | 2. 3 |
| Nonwhite | 213 | 222 | 225 | −5. 3 | −1. 3 | 231 | 238 | 251 | −2. 9 | 5. 5 |
| Combined | 181 | 185 | 186 | −2. 7 | −. 5 | 190 | 193 | 199 | −1. 6 | 3. 1 |

[1] The replacement ratios in this table are preliminary and are shown for illustrative purposes only. Ratios in Part A differ somewhat from those in Part B. Survival ratios used for the replacement ratios in Part A are from preliminary life table data supplied by the National Office of Vital Statistics. Survival ratios used for the replacement ratios in Part B are as indicated in the above text. Data are from the forthcoming cooperative study of the U. S. Agricultural Marketing Service and the U. S. Bureau of the Census, REPLACEMENT RATIOS AND RATES OF RURAL-FARM MALES OF WORKING AGES, 1950–60.

# Book Reviews

*British Economics Statistics.* By C. F. Carter and A. D. Roy. Cambridge University Press, New York. 188 pages. 1954. $4.

THE EXECUTIVE COMMITTEE of the British National Institute of Economics and Social Research in November 1950 initiated a project called "An Examination of British Economic Statistics." The main purpose was to appraise "the statistical information (*a*) required for or (*b*) actually used or available for, the formation of economic policy in the United Kingdom." This is the report of that project. The study was carried out by C. F. Carter of Queens University, Belfast, and A. D. Roy of Sidney Sussex College, Cambridge University, under the direction of a committee of leading economists and statisticians from British Universities.

The work is similar in many respects to the survey of the statistical agencies of the Federal Government of the United States made in 1948 by Frederick C. Mills and Clarence D. Long, then working with the National Bureau of Economic Research, for the Commission on Organization of the Executive Branch of the Government, commonly known as the "Hoover Commission."

The study was stimulated by two developments: (1) The increased use made of statistics in policy decisions, both public and private, and (2) the rapid growth in the volume of statistics made available, particularly during and since World War II. The latter development has been due largely to the collection of many additional data for use in administering governmental programs. Statistics from this source have been adapted for many uses for which they were not originally intended. Moreover, the growth of economic statistics is described as unequal in different fields and somewhat haphazard from the viewpoint of supplying the information most needed in making policy decisions. Therefore, a careful study of how resources available for carrying out statistical services can be used most effectively fills an important need.

The authors point out that their report differs from one that might be made by a Royal Commission appointed by the Government. They were not able to observe the use actually made of statistics in policy making or to learn how policy decisions in fact are made. Nor did they have access to all of the unpublished statistics available to the Government for the making of policy decisions. But this shortcoming is not large. The authors and the members of the committee under whose direction the study was made at one time or another have held responsible governmental positions.

In the first three chapters the authors describe the study in general terms, discuss the relation of statistics to economic and social policies, and summarize problems that they later consider in detail. The report starts out on a sound basis by recognizing that in policy-making information other than that of a statistical nature is required. The seven chapters that follow present case studies of the use of statistics and their adequacy in relation to policies and programs concerned with housing, coal, development areas, agricultural price fixing, the balance of external payments, and the general balance of the economy. The last four chapters deal with the quality of economic statistics, the presentation and availability of statistics, and the organization of statistical intelligence.

The book includes a useful reference table of principal British economic statistics and their sources and contains a summary index of the authors' main proposals and their suggestions for improvement of economic statistics. An extensive bibliography of references cited is included.

This is a useful reference book for those who are interested in improving the coverage and usefulness of economic statistics. It emphasizes throughout that to be useful statistics must be developed to serve a purpose or need. In other words, statistics must provide facts that will help

people in making decisions. The book should attract the interest of those who use economic statistics in making policy decisions as well as those who are responsible for making statistics of this kind available. The presentation is clear and effective. Laymen will find it readily comprehensible. At the same time it is thought-provoking for the social scientist.

*R. P. Christensen*

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*Land Problems and Policies.* By V. Webster Johnson and Raleigh Barlowe. McGraw-Hill, New York. 400 pages. 1954. $6.50.

THIS BOOK deals with the field of inquiry known as land economics. It pays its respects to orthodox economic subjects but its primary focus is on such institutional factors as population, property rights, public programs and policies, and the historical analysis of these institutions. The book clearly indicates that these are the things that are most influential in determining how people organize to use their resources. The authors discuss problems which have, in fact, been of major concern to people and their government.

*Land Problems and Policies* includes current subjects, such as soil conservation, multiple-purpose resource development, land resource planning, and land reform. It is comprehensive, and it carries for each problem an array of pertinent information—facts, ideas, program results, leads to other research, conclusions of the authors. The result is a book that has some of the characteristics of a collection of essays rather than a cold, logical, and systematic treatment of the problems.

The work could be used as a text for advanced college courses in land economics. Agricultural economists, particularly those who are concerned with recent trends in the profession and the significance of our results, would be well advised to give attention to this book. Reading it might well be the occasion for an appraisal of trends and emphasis in the agricultural economics profession. The senior author has been in the midst of land policy formulation and programs for more than 25 years, the junior author for 15, and the influence of L. C. Gray is both acknowledged and apparent. The book, therefore, deals with issues which, in the minds and experience of these three men, have been of major significance and have received major attention over the years.

Agricultural economics without question will ultimately be judged by how much it can help people to solve their problems. Yet, in the last 15 years, agricultural economists have paid less and less attention to the vital problems and issues here treated. The refinements in marginal analysis, in particular, have little to offer in devising solutions for land problems and guiding the formulation of land policies. Yet decisions are always being made, and land policy is continually being formed or modified.

It is difficult to avoid the conclusion that agricultural economists are abdicating their responsibilities in an area in which their training, research, and judgment should be of value. The recent reorganization of the United States Department of Agriculture and the reorientation of work in land economics is not reassuring in this regard.

*Raymond J. Penn*

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*Methods of Crop Forecasting.* By Fred H. Sanderson. Harvard University Press, Cambridge, Massachusetts. 259 pages. 1954. $5.

IT IS A PLEASURE to learn that Dr. Sanderson's award-winning dissertation, written 10 years ago, has been brought up to date and published. As the publishers accurately state, "this is the first book to present a survey and critical appraisal of crop forecasting methods, with a discussion of the relations between the various approaches and an evaluation of their relative

merits." Why this should be so is hard to understand, considering that crop forecasting is as old as civilization itself and has long been a well-established government activity in many countries. The United States alone has a century of experience in the field. Everyone interested in the subject is indeed fortunate that this first effort should be such an outstanding piece of work.

As the title indicates, the author has concentrated attention on one subject and has not attempted to cover the entire field of agricultural statistics. But it would be a mistake to leave the impression that this is all that is covered. A chapter on "Advances in the Design of Sample Surveys" provides an excellent review of modern sampling theory. A chapter on the "Validity of a Forecasting Formula" and another on "Testing Weather-Crop Hypotheses" are splendid expositions of multiple regression methods. They can be read with profit by anyone interested in those techniques, regardless of the field of application. Methods of appraising the significance of a fitted equation are treated exceptionally well.

The material relating specifically to crop forecasting covers in admirable style problems in estimating crop acreages, the use of subjective condition reports and their relation to yields, objective estimates of final yields, and objective yield forecasts from plant observations and weather data. Although many of the illustrations and examples are drawn from experience in the United States, the general approach is much broader, and frequent references are made to work in other countries.

The author has achieved a happy blend of the viewpoints of scientist and operating agency. When criticisms of methods currently in use in this country are made, they are more restrained than some that can be found elsewhere. His recommendations for possible improvements show a grasp of the practical problems with which an operating agency is faced, and are not in the ivory-tower category.

But Dr. Sanderson makes plain his belief that "greater accuracy and freedom from bias can only be achieved if the traditional crop-reporting methods based on the returns of crop correspondents are supplemented to an increasing extent by crop forecasts based on objective measurements of the weather and the growing crop" and that "interview sampling of nonrespondents to acreage surveys would also increase the reliability of the forecasts." He should be glad to learn that funds to conduct the type of research he advocates have been made available since his manuscript was prepared for publication. Work has been in progress for about a year.

Many readers will be interested in the comments on "the search for weather and crop cycles." Dr. Sanderson concludes that "there is no conclusive evidence that any of the periodicities hitherto suggested are real. All that can be said is that most of our weather series are not strictly random series, but show a significant degree of serial correlation or interdependence of successive observations. Whether this serial correlation is indicative of hidden periodicities or merely the result of a persistence tendency, it is impossible to say." He also concludes that "long-range weather forecasts cannot be expected to be sufficiently specific to serve as a basis for forecasting the yield of crops which are chiefly dependent on weather conditions prevailing during a few critical days."

Anyone who is interested in crop-yield statistics, whether user of data or actively engaged in crop estimating, may read this stimulating book with profit. The reviewer has no hesitation in recommending it to coworkers in the Crop and Livestock Reporting Service and to all users of crop statistics. The former will get an opportunity to view their work in a perspective that can be lost all too easily in the routine of day-to-day operations; the latter will become better acquainted with the complexities of a problem that is too often overy simplified by the uninitiated.

The style is lucid and readable. The mathematical formulas that appear in a few places are not troublesome. The reader can easily skip them, if he chooses, without seriously interrupting a chain of thought. But the little effort needed to interpret them will be well spent. For those who wish to pursue the subject further a good bibliography follows each chapter.

*Walter A. Hendricks*

*Conservation Law and Administration, A Case Study of Law and Resource Use in Pennsylvania.* By William F. Schulz, Jr. The Ronald Press Company, New York. 607 pages. 1953. $10.

THE ROLE THAT LAW PLAYS in the conservation of renewable natural resources is often overlooked by agricultural economists. Professor Schulz's work explores this role and in the process casts some grave doubts on the wisdom, when applied to resource use in Pennsylvania, of placing sole reliance on the classical economic doctrine that owners pursuing their own best interests assure full utilization, development, and conservation. His work also discloses a voluminous maze of conservation agencies and laws, sometimes conflicting, overlapping, and ineffective.

This book, sponsored by the Conservation Foundation, breaks new ground. For the first time, all laws—Federal, State, and local—pertaining to resource conservation in a State are carefully examined. The study depicts the value of an exhaustive analysis of the whole body of conservation law, as contrasted with generalizing about some segment of a field of law prevalent over the whole country. Under the latter approach, readers do not become aware of the immensely complex interrelationship of the whole pattern of laws that impinge on the problem.

Conservation of renewable natural resources is defined to mean utilization over all the future, not just until the present supply is exhausted. Resources dealt with, and around which the subject matter is arranged, include game, fish, water, forests, soil, and recreational values. Pennsylvania laws and pertinent Federal statutes relating to each are digested and commented upon. Also described in detail are the organization and operation of State and Federal agencies that administer these laws.

When reading this book one is humbled by the unitary nature of the conservation problem and then saddened by the slow progress made in integrating remedial measures. Activities of agencies charged with conservation of fish resources, as the author points out, are affected by power and navigational uses of streams, by urban, mine, and industrial pollution of waters, by inadequate forest cover on upper watersheds, and by failure to stabilize soils on farms. But conservation planning and management have often failed to reflect this unitary relationship. In achieving better integration, law can make a vital contribution.

Adequate conservation laws, of course, are neither self-enacting nor are they self-executing, once on the books. Laws must be supported by the people both before and after adoption, and traditions of economic freedom are highly allergic to governmental regulations. But such regulations have been accepted, though often reluctantly and at times belatedly.

Although erosion has wasted soils for decades, Pennsylvania only recently decided that soil needed aid by way of legislation—that laws were useful conservation tools. All efforts to control hunting failed until the virtual extinction of certain species made the critical situation clear. Forest conservation has been repeatedly frustrated by court decisions.

Professor Schulz points to the lack of effective coordination of natural resource planning and administration as a major weakness. Although more than 30 State departments, boards, and commissions are concerned with phases of resource conservation, no one agency has authority to integrate their activities. In his last chapter corrective measures are suggested—a model act for conservation administration. This act, reflecting the unitary nature of the conservation problem, proposes a Department of Conservation of 8 divisions, with the necessary power and discretion to plan and carry out a comprehensive conservation program.

This is a unique book and a welcome addition to conservation literature. Conservationists, administrators, lawyers, legislators, economists, researchers, and others cognizant of the role of law in conservation will find it both interesting and informative. An excellent introductory chapter summarizes the major findings and conclusions. It is not a book that one will read from cover to cover in one sitting. Several chapters, consisting largely of digests of existing laws, are heavy and tedious and may be skimmed over by the casual reader. When reading this book, one becomes aware of the lack of knowledge, first, as to how laws actually operate and, second, as to ways to make laws serve better. We are indebted to Professor Schulz for pioneering in new fields.

*Erling D. Solberg*

*Pilgrims in Paraguay.* By Joseph Winfield Fretz. Herald Press, Scottsdale, Pa. 247 pages. 1953. $2.75.

PILGRIMS IN PARAGUAY is a combination of a sociological-anthropological study and a record of one of the most heroic colonization projects of recent times. About two-fifths of the book is given to analyses of Mennonite colonies in other South American countries—Brazil, Uruguay, and Argentina. But the main portion of the book concerns itself with the Mennonite colonies in Paraguay, which are the focus of this review. Of the 16,000 Mennonites in South America, around 12,000 are in Paraguay.

This colonization began in 1926, when a group of Mennonites left Canada and settled in the Chaco, the deep interior of Paraguay. The last great influx of new settlers was in 1947, when refugees from Russia and a few other European countries came by the hundreds into Paraguay. Some of the refugees were filtered in among established colonies, and others established new colonies of their own. There are now 7 main colonies.

Mennonites are the most successful colonizers in the world, for two reasons—first, probably, their religious conviction that adversity is a perquisite to righteousness, and second, their simple unostentatious life. Because of these two qualities, Mennonites succeed where many another people would fail. In the Paraguayan Chaco, however, they have truly been put to the test. This book, a critical review by a Mennonite scholar, does not claim that their experiences have been completely successful.

They chose Paraguay because the Paraguayan Government would grant their desire not to be involved in war, or indeed in any other type of violence, and to live approximately as a government within a government. Their colonies are little conditioned by the Government of Paraguay, and because of their isolation they are influenced little by indigenous populations, whether Indian or Paraguayan. They are pioneers, as Mennonites always have been, not only because they moved into an undeveloped agricultural area, but because, being so isolated from the economy of the world, even to a large extent from that of Paraguay, the story of their development is to a considerable degree a recapitulation of the developing economy of Western society.

In the first place, they had to live upon what the local environment and its resources produced. Even horses and mules were not available; they had to break wild cattle as work animals. Their simple farm implements, although not as primitive as those used in some other parts of Paraguay, were as primitive as any used by American pioneers 200 years ago. Their processing and manufacturing enterprises are still mostly in the handicraft or domestic industry stage, and they market little of what they produce.

The story of the Paraguayan colonies is therefore an interesting study in the economic development of society. With all the fortitude in the world, backed by deep religious convictions, these people could not triumph completely over forbidding physical and ecological conditions—a semi-arid area with poorly distributed rainfall, a spring climate in which crops may have to be replanted 3 or 4 times, infestations of grasshoppers that reproduce prolifically in surrounding wooded areas, and physical isolation in terms of market contacts.

As the author says, and I think correctly, "The most significant achievements of the Mennonites are not in the realm of material progress or technical advancement. They are in the psychological and spiritual values. Mennonites in Paraguay today enjoy 3 priceless possessions—bread, freedom, and peace." Nevertheless an amazing amount of material and technical advance has been made by the colonies, and it is a growing leaven in Paraguayan economy. If one reads this story he will be convinced that none but Mennonites could have accomplished so much.

*Carl C. Taylor*

*The Social Economics of Agriculture.* By William Gee. The Macmillan Company, New York. 616 pages. 1954. $6.50.

THIS IS THE THIRD EDITION of Professor Gee's book, which attempts to comprehend within its covers the more significant of the materials in the fields of both agricultural economics and rural sociology. Previous editions were published in 1932 and 1942. This edition covers the same general area as the second, except that the chapter "Some Political Problems" is not included. Tables and discussion are brought up to date by use of the 1950 Census and other sources. Similarly, suggested readings at the end of each chapter are revised to include many recent publications. The book is a popular text for universities and colleges in which only one course can be given in this field.

*Agricultural Finance—Principles and Practice of Farm Credit.* By William G. Murray. Iowa State College Press, Ames, Iowa. 419 pages. 1953. $4.50.

IN THIS, the third edition of Mr. Murray's book, first published in 1943, a new chapter on risk, insurance, and investment has been added, and the chapter on natural hazards has been rewritten. The addition of much new material on commercial banks has resulted in a second chapter on these lending institutions. Other changes include new legislation, recent farm finance statistics, and an evaluation of farm credit changes since publication of the second edition in 1947.

## Selected Recent Research Publications in Agricultural Economics Issued by the United States Department of Agriculture and Cooperatively by the State Colleges [1]

Anderson, Roice H., and Downs, Glen E. the relation between gradings of live and dressed chickens in utah. Utah Agr. Expt. Sta. Bull. 366, 16 pp., illus. Western Regional Research Publication. February 1954. (Agr. Expt. Sta. of Alaska, Ariz., Calif., Colo., Hawaii, Idaho, Mont., Nev., N. Mex., Oreg., Utah, Wash., and Wyo., and AMS cooperating.)

In Utah, light hens graded approximately 68 percent A, 24 percent B, and 8 percent C by U. S. standards. Other classes of chickens ranged from 82 to 84 percent grade A, 14 to 16 percent B, and 1 to 2 percent C.

Bredo, William, Shreve, Robert O., Hamman, Charles L. transportation problems of expanding western agriculture. 227 pp., illus. Agr. Mktg. Serv. June 1954. (Processed.) (RMA)

Agriculture's interest in transportation falls generally into three categories: (1) The level of freight rates and freight-rate relationships among competitive producing areas and between them and the economy generally; (2) the adequacy of service; and (3) general regulating policies which have a basic influence on agricultural transportation.

[1] Processed reports are indicated as such. All others are printed. State publications may be obtained from the issuing agencies of the respective States.

Davis, Joe F. electricity on farms in new york and new england. U. S. Dept. Agr. Agr. Inform. Bull. 124, 42 pp., illus. July 1954. (Agr. Res. Serv.)

Analyzes the experiences of farmers of New York and New England in the use of electricity and electrical equipment.

Foelsch, Gertrude G. seasonality of milk production under the louisville fall premium plan. U. S. Dept. Agr. Mktg. Res. Rept. 63, 47 pp., illus. May 1954. (RMA)

From 1950 through 1952 the fall-spring ratios of daily delivery of milk per producer in the Louisville area ranged from 80 to 82 percent as compared with 73 to 76 percent for 1941 through 1943. The reduction in seasonality has contributed to more efficient and stable marketing of milk than existed when the plan was introduced in 1943.

Goodsell, Wylie D., Brown, W. Herbert, Fowler, Herbert C., Hole, Erling, Hurd, Edgar B., Vermeer, James, and Jenkins, Isabel. farm costs and returns, 1953 (with comparisons). commercial family operated farms, by type and location. U. S. Dept. Agr. Agr. Inform. Bull. 128, 44 pp., illus. June 1954. (Agr. Res. Serv.)

This bulletin presents costs and returns in 1953 for 19 types of commercial family operated farms.

HAYNES, BENJAMIN C., JR. WHITE POTATO STORAGES FOR NEW JERSEY, LONG ISLAND, AND SOUTHEASTERN PENNSYLVANIA. U. S. Dept. Agr. Mktg. Res. Rept. 70, 17 pp., illus. June 1954. (RMA)

Storage of potatoes is a practical method of minimizing price fluctuations in local markets. Insulated structures above ground are desirable, and automatic control of forced ventilation systems is essential. Palletized handling is adaptable to bulk or bag storage, but cost of equipment restricts this method to large storages.

HECHT, REUBEN W. and VICE, KEITH R. LABOR USED FOR FIELD CROPS. U. S. Dept. Agr. Statis. Bull. 144, 45 pp. June 1954. (Agr. Res. Serv.)

Amount and cost of labor saved by adopting mechanical methods of performing farm work will continue to be an important consideration in farm planning. Data in this publication are expected to be useful to extension workers and others who are responsible for aiding farmers in this field.

HERRMANN, LOUIS F., ANDERSON, ELSIE D., and BELE, FRANK A. ESTIMATING THE SOLIDS-NOT-FAT CONTENT OF MILK. U. S. Dept. Agr. Mktg. Res. Rept. 65, 13 pp., illus. May 1954. (RMA)

The average percentage of solids-not-fat content of milk delivered by individual producers at 16 milk-processing plants was estimated from the fat percentage with a standard error of estimate of 0.29. When specific gravity was included in the estimating equation, the standard error of estimate was reduced to 0.20.

HERRMANN, LOUIS F., BRYAN, W. G. and ANDERSON, ELSIE. SAMPLING ROUTINES AND THE ACCURACY OF PATRONS' BUTTERFAT TESTS. U. S. Dept. Agr. Mktg. Res. Rept. 66, 23 pp., illus. May 1954. (RMA)

Butterfat percentages of about 2 daily samples in 3 fell within 0.196 (one standard deviation) of producer's monthly average. Composite samples gave lower monthly average butterfat percentages than samples of fresh milk tested daily.

HUNTER, D. LOYD, DUERDEN, RAOUL S., and KAFER, FRANCIS, Washington State Apple Commission, and HERRICK, JOSEPH F., JR. HANDLING EMPTY APPLE BOXES IN PACIFIC NORTHWEST PACKING AND STORAGE HOUSES. U. S. Dept. Agr. Mktg. Res. Rept. 71, 36 pp., illus. June 1954. (RMA)

When the manual method of moving empty apple boxes was used, labor and equipment costs were $3.44 per 1,000 boxes. Costs of using clamp-type 2-wheel hand trucks were $1.35, and costs of using industrial fork-lift trucks and pallets were $2.24.

JONES, LAWRENCE A., and GARLOCK, FRED L. FACTORS AFFECTING FARM-LOAN INTEREST RATES. U. S. Dept. Agr. Agr. Inform. Bull. 126, 22 pp., illus. May 1954.

Reviews some of the principal factors that influence rates of interest and considers the probable trend of the rates that farmers will pay in the near future.

MARTIN, WILLIAM J., and ASHBY, WALLACE L. MARKET OUTLETS FOR COTTON IN SOME OF THE PRINCIPAL COTTON FABRICS—SUPPLEMENT III. 24 pp., illus. Agr. Mktg. Serv. June 1954. (Processed.) (RMA)

Fancy denims, cotton blankets, and tufting yarns consumed almost one-half million bales of cotton in 1953. Demand for denims has been stimulated by the bright colors and smart styles made available by cotton manufacturers.

PETERS, C. W., REED, ROBERT H., and CREEK, C. RICHARD. MARGINS, SHRINKAGE, AND PRICING OF CERTAIN FRESH VEGETABLES IN HONOLULU. Hawaii Agr. Expt. Sta. Agr. Econ. Bull. 7, 31 pp., illus. (Hawaii Agr. Expt. Sta. and AMS cooperating.) June 1954. (RMA)

About a third of the consumer dollar was required to cover the retail margin realized on the six vegetables studied. Shrinkage cost at retail average 4.6 cents and at wholesale about 5 cents per dollar of retail sales. Wholesale margins accounted for almost 16 cents. These marketing charges represented approximately 60 cents of each dollar spent by consumers for the six vegetables.

PRITCHARD, NORRIS T. AN IMPROVED METHOD OF PRICING FAT AND NONFAT SOLIDS IN MILK. 23 pp. Agr. Mktg, Serv. July 1954. (Processed.)

Two formulas for establishing milk fat differentials were developed. One establishes differentials to be used in conjunction with use-class prices paid by handlers. The other sets differentials for producer (blend) prices. Both are based on market values of butter and nonfat dry milk solids.

STOKES, DONALD R., and HAWES, RUSSELL L. TRADE REACTION TO WINTER PEARS PACKED IN FIBERBOARD BOXES. 11 pp. Agr. Mktg. Serv. August 1954. (Processed.)

Most wholesalers were favorably impressed with the fiberboard container's ability to minimize injury to fruit; many were apprehensive over the stacking and trucking capabilities and disapproved of the slackness of pack. Reaction of retailers generally was favorable to the fiberboard container. Auction market buyers discounted pears packed in fiberboard boxes.

UNITED STATES AGRICULTURAL MARKETING SERVICE. A DIGEST OF PROGRESS REPORTS ON MARKETING SERVICE PROGRAMS—CONDUCTED BY STATE DEPARTMENTS OF AGRICULTURE AND BUREAUS AND DIVISIONS OF MARKETS IN COOPERATION WITH AGRICULTURAL MARKETING SERVICE, JULY 1, 1952—SEPTEMBER 30, 1953. 77 pp. June 1954. (Processed.)

UNITED STATES AGRICULTURAL MARKETING SERVICE. FIBERS AND OTHER MATERIALS USED IN INSULATING ELECTRIC WIRE AND CABLE. PRELIMI-

NARY SUMMARY REPORT ON VOLUME OF CONSUMPTION. 5 pp. June 1954. (Processed.) (RMA)

Items covered in this study were communication wire and cable, magnet wire, weatherproof and slow-burning wire and cable, building wire and cable, power wire and cable, appliance wire and cord, and automotive and aircraft wire and cable.

UNITED STATES AGRICULTURAL MARKETING SERVICE. HOMEMAKERS' USE OF AND OPINIONS ABOUT FATS AND OILS USED IN COOKING. U. S. Dept. Agr. Mktg. Res. Rept. 67, 88 pp., illus. June 1954. (RMA)

Most housewives in this country use at least three different kinds of fats and oils for their home cooking—usually a combination of butter and two other fats such as vegetable shortening, lard, shortening compound, cooking oil, or margarine.

WEBB, ROBERT W. COMPARISON OF THE RELATIONS OF SIX FACTORS OF RAW-COTTON QUALITY TO SKEIN STRENGTH OF CARDED YARNS FOR EIGHT CROP YEARS, 1945–52. Agr. Mktg. Serv. 33 pp., illus. May 1954. (Processed.)

This report summarizes and compares correlation results that were obtained with skein strength of 22s carded yarn and with count-strength product of all yarn sizes spun from each cotton, representing 10 series of cotton and identified with 8 consecutive years.

WILMETH, JO BRICE, and BOLT, CHARLES D. BREAKING OUT BALES OF COTTON STORED ON HEAD. U. S. Dept. Agr. Mktg. Res. Rept. 61, 23 pp., illus. May 1954. (RMA)

When cotton was stored on head 2 bales high in paired rows, the approximate direct costs for breaking out 100 bales was $20 by the manual method with a 4-man crew, $9 with boom truck and 3 men, and $5 with lift truck and 1 man.

WILSON, DONALD E., and DEVER, GEORGE B., JR. OBJECTIVE EVALUATION OF COLOR OF TOMATOES FOR PROCESSING. 28 pp. Agr. Mktg. Serv. June 1954. (Processed.) (RMA)

Gives findings of an investigation of the possibility of ascertaining the quality of tomatoes for processing on the basis of an objective evaluation of color combined with a subjective determination of the percentage of grade defects.

## Statistical Compilations

O'DONNELL, P. E. NONFARM CONSUMPTION OF FLUID MILK AND CREAM. A REVISED SERIES OF STATISTICS (UNITED STATES, 1924–50; URBAN MARKETS, 1944). U. S. Dept. Agr. Mktg. Res. Rept. 72, 51 pp., illus. May 1954.

UNITED STATES AGRICULTURAL MARKETING SERVICE. CORN: ACREAGE, YIELD, AND PRODUCTION OF ALL CORN, CORN FOR GRAIN, CORN FOR SILAGE, AND ACREAGE FOR FORAGE, BY STATES, 1866–1943. 56 pp. June 1954. (Processed.)

UNITED STATES AGRICULTURAL MARKETING SERVICE. OATS: ACREAGE, YIELD, AND PRODUCTION, BY STATES, 1866-1943. 29 pp. June 1954. (Processed.)

UNITED STATES AGRICULTURAL MARKETING SERVICE. REVISIONS OF ICE CREAM AND ICE MILK DATA, BY STATES, 1940–49. 6 pp. July 1954. (Processed.)

UNITED STATES AGRICULTURAL MARKETING SERVICE. SUGAR BEETS: ACREAGE, YIELD, PRODUCTION, PRICE, AND VALUE. SUGAR, PULP, AND MOLASSES PRODUCTION FOR UNITED STATES, BY STATES, 1924–52. 35 pp. June 1954. (Processed.)

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